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VIEW OF THE ICE AGE AS TWO EPOCHS, THE GLACIAL AND CHAMPLAIN.*

THE present paper supplements that presented by the author in the Proceedings of this Association a year ago, which showed the Quaternary era as divided into the Lafayette, Glacial and Recent periods. The Glacial period or Ice age is here more particularly reviewed, and is found divisible into two parts or epochs, the first or Glacial epoch being marked by high elevation of the drift-bearing areas and their envelopment by vast ice sheets, and the second or Champlain epoch being distinguished by the subsidence of these areas and the departure of the ice with abundant deposition of both glacial and modified drift. Epeirogenic movements, first of great uplift, and later of depression, are thus regarded as the basis of the two chief time divisions of the Ice age. Each of these epochs is further divided into stages, marked in the Glacial epoch by fluctuations of the predominant ice accumulation, and in the Champlain epoch by successively diminishing limits of the waning ice sheet.

Studies by many observers have shown that both in North America and Europe the border of the drift along the greater part of its extent was laid down as a gradually attenuated sheet; that the ice retreated and the drift underwent much subaërial erosion

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and denudation; that renewed accumulation and growth of the ice sheets, but mostly without extending to their earlier limits, were followed by a general depression of these burdened lands, after which the ice again retreated, apparently at a much faster rate than before, with great supplies of loess from the waters of its melting; that moderate reëlevation ensued, and that during the farther retreat of the ice sheets prominent moraines were amassed in many irregular but roughly parallel belts, where the front at successive times paused or re-advanced under secular variations in the prevailing temperate and even warm climate by which, between the times of formation of the moraines, the ice was rapidly melted away.

Such likeness in the sequence of glacial conditions doubtless implies contemporaneous stages in the glaciation of these two continents; and the present writer believes that it is rather to be interpreted as a series of phases in the work of a single ice sheet on each area than as records of several separated and independent epochs of glaciation, differing widely from one another in their methods of depositing drift.

Under the latter view, however, Geikie distinguishes no less than eleven stages or epochs, glacial and interglacial, which he has very recently named (*Journal of Geology*, Vol. III., pp. 241-269, April-May, 1895), since the publication last year of the new edition of his 'Great Ice Age,' in which, however, they were fully described. These divisions of the Glacial period are as follows: 1. The Scanian or first glacial epoch; 2. The Norfolkian or first interglacial epoch; 3. The Saxonian or second glacial epoch; 4. The Helvetian or second interglacial epoch; 5. The Polandian or third glacial epoch; 6. The Neudeckian or third interglacial epoch; 7. The Mecklenburgian or fourth glacial epoch; 8. The Lower Forestian or fourth interglacial epoch; 9. The Lower Turbarian or fifth

glacial epoch; 10. The Upper Forestian or fifth interglacial epoch; and 11. The Upper Turbarian or sixth glacial epoch.

The earliest application of such geographic names to the successive stages and formations of the Ice age appears to be that of Chamberlin in his two chapters contributed to the new third edition of Geikie's admirable work before mentioned, in which he names the Kansan, East Iowan, and East Wisconsin formations. For the second and third he has since adopted the shorter names, Iowan and Wisconsin. This classification he has more recently extended (in the *Journal of Geology*, Vol. III., pp. 270-277, April-May, 1895), the interglacial stage and deposits between the Kansan and Iowan till formations being named Aftonian, and the Toronto interglacial formation, previously named, being referred, with some doubt, to an interval between the Iowan and Wisconsin stages. Chamberlin correlates, with a good degree of confidence, his Kansan stage of maximum North American glaciation with the maximum in Europe, which is Geikie's Saxonian epoch; the Aftonian stage as Geikie's Helvetian; the Iowan as the European Polandian; and the Wisconsin or moraine-forming stage of the United States as the Mecklenburgian, which was the stage of the 'great Baltic glacier' and its similarly well developed moraines. According to the law of priority, the names of the Kansan, Iowan and Wisconsin formations and stages should also be applied to these European divisions of the Glacial series, for the studies of Geikie and Chamberlin show them to be in all probability correlative and contemporaneous.

Differing much from the opinions of Geikie, and less widely from those of Chamberlin, concerning the importance, magnitude and duration of the interglacial stages, but agreeing with Dana, Hitchcock, Wright, Kendall, Falsan, Holst, Nikitin and others

in regarding the Ice age as continuous, with fluctuations but not complete departure of the ice sheets, my view of the history of the Glacial period, comprising the Glacial epoch of ice accumulation and the Champlain epoch of ice departure, may be concisely presented in the following somewhat tabular form. The order is that of the advancing sequence in time, opposite to the downward stratigraphic order of the glacial, fluvial, lacustrine and marine deposits.

EPOCHS AND STAGES OF THE GLACIAL PERIOD.

I. The Glacial Epoch.

1. THE CULMINATION OF THE LAFAYETTE EPEIROGENIC UPLIFT, affecting both North America and Europe, raised the glaciated areas to so high altitudes that they received snow throughout the year and became deeply ice-enveloped. Valleys and fjords show that this elevation was 1,000 to 4,000 feet above the present height.

Rudely chipped stone implements and human bones in the plateau gravels of southern England, 90 feet and higher above the Thames, and the similar traces of man in high terraces of the Somme valley, attest his existence there before the maximum stages of the uplift and of the Ice age. America appears also to have been already peopled at the same early time.

The accumulation of the ice sheets, due to snowfall upon their entire areas, was attended by fluctuations of their gradually extending boundaries, giving the Scanian and Norfolkian stages in Europe, and an early glacial recession and re-advance in the region of the Moose and Albany rivers, southwest of James Bay.

2. KANSAN STAGE. Farthest extent of the ice sheet in the Missouri and Mississippi river basins, and in northern New Jersey. The Saxonian stage of maximum glaciation in Europe.

Area of the North American ice sheet,

with its development on the Arctic archipelago, about 4,000,000 square miles; of the Greenland ice sheet, then somewhat more extended than now, 700,000 square miles or more, probably connected over Grinnell land and Ellesmere land with the continental ice sheet [the area of Greenland is approximately 680,000 square miles, and of its present ice sheet 575,000 square miles]; of the European ice sheet, with its tracts now occupied by the White, Baltic, North and Irish seas, about 2,000,000 square miles.

Thickness of the ice in northern New England and in central British Columbia, about one mile; on the Laurentide highlands, probably two miles; in Greenland, as now, probably one mile or more, with its surface 8,000 to 10,000 feet above the sea; in portions of Scotland and Sweden, and over the basins of the Baltic sea, a half mile to one mile.

3. HELVETIAN OR AFTONIAN STAGE. Recession of the ice sheet from its Kansan boundary northward about 500 miles to Barnesville, Minn., in the Red river valley; 250 miles or more in Illinois, according to Leverett; but probably little between the Scioto river, in Ohio, and the Atlantic coast, the maximum retreat of that portion being 25 miles or more in New Jersey. A cool temperate climate and coniferous forests up to the receding ice border in the upper Mississippi region. Much erosion of the early drift.

The greater part of the drift area in Russia permanently relinquished by the much diminished ice sheet, which also retreated considerably on all its sides.

During this stage the two continents probably retained mainly a large part of their preglacial altitude. The glacial recession may have been caused by the astronomic cycle which brought our winters of the northern hemisphere in perihelion between 25,000 and 15,000 years ago.

4. IOWAN STAGE. Renewed ice accumu-

lation, covering the Aftonian forest beds, and extending again into Iowa, to a distance of 350 miles or more from its most northern indentation by the Aftonian retreat, and re-advancing about 150 miles in Illinois, while its boundary eastward from Ohio probably remained with little change.

The Polandian stage of renewed growth of the European ice sheet, probably advancing its boundaries in some portions hundreds of miles from the Helvetian retreat.

II. The Champlain Epoch.

5. CHAMPLAIN SUBSIDENCE; NEUDECKIAN STAGE. Depression of the ice-burdened areas mostly somewhat below their present heights, as shown by fossiliferous marine beds overlying the glacial drift up to 300 feet above the sea in Maine, 560 feet at Montreal, 300 to 400 feet from south to north in the basin of Lake Champlain, 300 to 500 feet southwest of Hudson and James bays, and similar or less altitudes on the coasts of British Columbia, the British Isles, Germany, Scandinavia and Spitzbergen.

Glacial recession from the Iowan boundaries was rapid under the temperate (and in summers warm or hot) climate belonging to the more southern parts of the drift-bearing areas when reduced from their great preglacial elevation to their present height or lower. The finer portion of the englacial drift, swept down from the ice fields by the abundant waters of their melting and of rains, was spread on the lower lands and along valleys in front of the departing ice as the loess of the Missouri, the Mississippi and the Rhine. Marine beds reaching to a maximum height of about 375 feet at Neudeck, in western Prussia, give the name of this stage.

6. WISCONSIN STAGE. Moderate reëlevation of the land in the northern United States and Canada, advancing as a perma-

nent wave from south to north and northeast; continued retreat of the ice along most of its extent, but its maximum advance in southern New England, with fluctuations and the formation of prominent marginal moraines; great glacial lakes on the northern borders of the United States.

The Mecklenburgian stage in Europe. Conspicuous moraine accumulations in Sweden, Denmark, Germany and Finland, on the southern and eastern margins of the great Baltic glacier. No extensive glacial re-advance between the Iowan and Wisconsin stages, either in North America or Europe.

7. WARREN STAGE. Maximum extent of the glacial Lake Warren, held on its northeast side by the retreating ice border, one expanse of water, as mapped by Spencer, Lawson, Taylor, Gilbert and others, from Lake Superior over Lakes Michigan, Huron and Erie, to the southwestern part of Lake Ontario; its latest southern beach traced east by Gilbert to Crittenden, N. Y., correlated by Leverett with the Lockport moraine.

This and later American stages, all of minor importance and duration in comparison with the preceding, cannot probably be shown to be equivalent with Geikie's European divisions belonging in the same time.

8. TORONTO STAGE. Slight glacial oscillations, with temperate climate nearly as now, at Toronto and Scarboro', Ont., indicated by interbedded deposits of till and fossiliferous stratified gravel, sand and clay. Although the waning ice sheet still occupied a vast area on the northeast, and twice re-advanced, with deposition of much till, during the formation of the Scarboro' fossiliferous drift series, the climate then, determined by the Champlain low altitude of the land, by the proximity of the large glacial lake Algonquin, succeeding the larger lake Warren, and by the eastward and northeastward surface atmospheric currents

and courses of all storms, was not less mild than now. The trees whose wood is found in the interglacial Toronto beds now have their most northern limits in the same region.

9. IROQUOIS STAGE. Full expansion of the glacial Lake Iroquois in the basin of the present Lake Ontario and northward, then outflowing at Rome, N. Y., to the Mohawk and Hudson rivers. Gradual reëlevation of the Rome outlet from the Champlain subsidence had lifted the surface of Lake Iroquois in its western part from near the level of the present lake at Toronto to a height there of about 200 feet, finally holding this height during many years, with the formation of the well developed Iroquois beach.

Between the times of Lakes Warren and Iroquois, the glacial Lake Lundy, named by Spencer from its beach ridge of Lundy's Lane, probably had an outlet east to the Hudson by overflow across the slope of the highlands south of the Mohawk; but its relationship to the glacial Lake Newberry, named by Fairchild as outflowing to the Susquehanna by the pass south of Seneca Lake, needs to be more definitely ascertained.

10. ST. LAWRENCE STAGE. The final stage in the departure of the ice sheet which we are able to determine from the history of the Laurentian lakes and St. Lawrence valley was when the glacial Lake St. Lawrence, outflowing through the Champlain basin to the Hudson, stretched from a strait originally 150 feet deep over the Thousand Islands, at the mouth of Lake Ontario, and from the vicinity of Pembroke, on the Ottawa river, easterly to Quebec or beyond. As soon as the ice barrier was melted through, the sea entered these depressed St. Lawrence, Champlain and Ottawa valleys; and subsequent epeirogenic uplifting has raised them to their present slight altitude above the sea level.

Later stages of the glacial recession are doubtless recognizable by moraines and other evidences, the North American ice sheet becoming at last, as it probably also had been in its beginnings, divided into three parts, one upon Labrador, another northwest of Hudson Bay, as shown by Tyrrell's observations, and a third upon the northern part of British Columbia. From my studies of the glacial Lake Agassiz, whose duration was probably only about 1,000 years, the whole Champlain epoch of land depression, the departure of the ice sheet because of the warm climate so restored, and most of the reëlevation of the unburdened lands, appear to have required only a few (perhaps four or five) thousand years, ending about five thousand years ago. These late divisions of the Glacial period were far shorter than its Kansan, Aftonian and Iowan stages; and the ratio of the Glacial and Champlain epochs may have been approximately as ten to one. The term Champlain conveniently designates the short final part of the Ice age, when the land depression caused rapid though wavering retreat of the ice border, with more vigorous glacial currents on account of the marginal melting and increased steepness of the ice front, favoring the accumulation of many retreatal moraines of very knolly and bouldery drift.

WARREN UPHAM.

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HELIUM AND ARGON.

BRIEF accounts of the discovery of helium and argon have already appeared in the pages of this journal. More recently, several important observations have been made, which, while not establishing with certainty the nature of these substances and their places in the system of the elements, at least afford a reasonable basis for speculation.

Helium was originally obtained from the

uranium minerals cleveite, bröggerite and Connecticut uraninite. Ramsay has since detected it in small amounts in several other minerals and in the gases occluded or combined in certain meteoric irons. The uranium minerals give the best yield, but it is also found in smaller quantities in samarskite, orangite and monazite, and in traces in yttrotantalite, hjelmite, fergusonite, tantalite, polycrase and xenotime. All of these, including the uranium minerals above mentioned, are of comparatively rare occurrence and are found in small quantities only. They are all of complex composition and each contains several so-called 'rare earths.' It is a noteworthy fact that all minerals thus far found to contain helium consist in part of one or more of the elements uranium, thorium and yttrium, and it would seem that it is in some way associated with these, especially with uranium. As to the nature of this association nothing whatever is known, and attempts to cause them to recombine with helium have thus far failed.

Helium has also been found in the gases escaping from certain mineral springs. Kayser, of Bonn, has detected it in the gas from the Wildbad spring in the Black Forest. After sparking with oxygen to remove nitrogen, which is the chief constituent, 340 c. c. of the gas left a residue of 9 c. c., which gave a brilliant helium spectrum. Bouchard has found it associated with nitrogen and sometimes also with argon, in the gas obtained from several sulphur springs in the Pyrenees. As it is thus constantly escaping, we might well expect to detect it in traces in the atmosphere, and Kayser claims to have observed faint helium lines in the spectrum of the purest argon obtained from the atmosphere of Bonn. In fact, it seems to be a very widely distributed substance.

Cleve and Langlet have obtained helium with a density as low as 2.02, or about

double that of hydrogen; it is, therefore, next to hydrogen, the lightest gas known. This figure corresponds to a molecular weight of 4.04, and since the molecules of the gas appear to consist of single atoms, like those of argon, 4.04 represents the approximate atomic weight also. The importance of this observation lies in the fact that, although our present classification of the elements would lead us to infer the existence of several elements with atomic weights between those of hydrogen (at. wt. 1) and lithium (at. wt. 7), none of these are known. Helium may, therefore, well be one of these missing substances.

Careful spectroscopic studies by Crookes, Lockyer, Runge and Paschen, and others, have shown, however, that what we now call *helium* is not a single substance, but a mixture of two or more hitherto unknown gases. The composition of the mixture varies both qualitatively and quantitatively according to the source from which it is obtained. Crookes has published a very elaborate study of the spectra of samples of helium from different varieties of uraninite, from which it appears that even these are not absolutely identical. Sixteen bright lines are mentioned as common to all these samples of helium, including the famous D_3 line, first seen by Lockyer and Frankland in the solar spectrum. The gas from Connecticut uraninite seems to be the most complex and shows fourteen strong lines which are absent from the spectra of other varieties and presumably belong to another element. Twenty-seven lines are mentioned which seem to coincide with lines of the solar spectrum.

Runge and Paschen, who have studied the spectrum of the gas from cleveite, including the invisible ultra-red portion, have reached the conclusion that even this gas consists of two substances, one of which, the true helium, giving the D_3 line, is denser than the other (unnamed) constitu-

ent, which also shows a characteristic spectrum. The difference of density was detected by the slower rate of diffusion of the true helium, implying higher density. From spectroscopic considerations they are able to separate the composite spectrum into its two constituents, and to conclude that the true helium may have an atomic weight of about 5, and the other of not far from 3. Both of these substances, according to Kayser, are present in the gas from the Wildbad spring, while according to Bouchard helium from the Pyrenean springs also contains a second ingredient. The lines of both constituents of helium have also been noted in the spectra of several stars.

It was formerly asserted that helium and atmospheric argon have a constituent in common, this belief being based on the existence of a certain set of spectral lines common to both. Recent observations by Lockyer, with an instrument of high dispersive power, indicate that this coincidence is not exact, and hence that the theory of a common constituent is without foundation.

The only evidence favoring the view that atmospheric argon, as thus far obtained, is pure is found in the apparently constant boiling point of liquid argon, as observed by Olszewski. It may be questioned whether an experiment with only 1–10 c. c. of liquid is sufficient to prove the total absence of other substances of unknown boiling points. All samples of atmospheric argon naturally have the same composition, being derived from the same source, and argon from other sources has not yet been studied with sufficient accuracy to throw any light on the matter. It is therefore quite likely that the atomic weight of 40 will have to be changed to the extent of one or more units.

From these results it is obvious that the present figures for the atomic weights of

helium and argon, which are based on density determinations with impure material, must be regarded as provisional, but it is evident that one at least of the constituents of crude helium must have an atomic weight lower than the mean and hence must precede lithium. As it is possible that both crude helium and crude argon contain even more than two gases, the problem of their complete separation will doubtless be one of considerable difficulty, especially as all seem to possess a high degree of inertness.

The few experiments thus far made for the purpose of ascertaining if argon is a constituent of living beings have failed to detect it.

At present there is no evidence that any of these gases are decomposable into simpler constituents, and until such evidence is forthcoming we may continue to regard them as elementary.

Attempts to produce compounds of argon have given some indications of succeeding, but as yet no substances of definite and constant composition have been obtained. Besides the compound with benzene vapor described by Berthelot, this chemist has obtained a solid by submitting a mixture of argon and carbon disulphide vapor, confined over mercury, to the action of the electric discharge. This substance is said to evolve argon on heating. Ramsay found that, by forming an electric arc between carbon rods in an atmosphere of argon, the spectrum of argon nearly vanished after several hours' action, its place being taken by a brilliant 'channeled' spectrum. According to Crookes this shows many analogies with the spectra of carbon compounds, and may well proceed from a compound of carbon with argon. If Ramsay's observation that an *increase* of one fifth volume occurs should be confirmed, it would seem to do away with the view that argon molecules are monatomic, for a monatomic gas cannot increase in volume on entering into combination.

It was early observed that the metallic electrodes in the Plücker tubes used for obtaining spectra were very effective in removing traces of nitrogen. Even helium seemed to be slowly absorbed, its spectrum gradually becoming fainter and ultimately vanishing. Troost and Ouvrard have found that a powerful silent discharge through tubes of argon or helium containing magnesium or even platinum causes absorption of the gases. The absorption is exceedingly slow, but is ultimately complete. Nothing is known as to the nature of the products.

The elementary nature of helium has been very generally conceded. Several hypotheses assuming argon to be a compound of known or unknown elements have been suggested, most of which are without the least experimental basis, and need not be noticed here. A view which earlier met with considerable approval is that the argon molecule consists of three nitrogen atoms, N_3 . This allotropic form of nitrogen has never been obtained, and we have no means of predicting whether it would be more stable than the common form, N_2 . If more stable, and if formed in small amounts in the course of ages, it would tend to accumulate in the atmosphere. This view was supported by a not very close coincidence of densities, argon having a density of about 20, while the density of N_3 would be 21. Not the slightest evidence has been found, however, that argon and nitrogen are convertible into each other, even in traces, while such transformations are quite readily effected in all known cases of allotropism. Neither is argon formed when nitrogen is liberated from combination. If it is a more stable form of nitrogen it should be one, if not the main product under these circumstances, just as ordinary oxygen, not ozone, is the chief product when this element is set free. Until it can be shown that the evidence of the specific heat ratio, which is based on the kinetic theory of gases, is inconclusive, or

until argon is actually decomposed into simpler or familiar substances, we must regard it as a new element.

The elementary nature of the new gases being conceded, the first question which arises is whether they represent an entirely new order of substances, or whether they can be harmonized with the classification which has been found to apply to all known chemical elements whose properties have been established with any degree of exactness, and if so whether this system will admit of their adoption without any essential change, or whether it must be more or less modified and extended.

Our present classification is known as the Periodic or Natural System, and is based on a consideration of the broad chemical properties of the elements, rather than on special similarities or differences such as are considered in a classification for analytical or other practical purposes. If the elements be arranged in the order of increasing atomic weights there is a gradual modification of chemical properties as we ascend in the series, but this does not proceed uninterruptedly in the same sense through the entire list. At certain points there is a break, and the following element has properties resembling one several places back. This abrupt change is perhaps most obvious in respect to the metallic and base forming, and the non-metallic and acid forming properties, and is well illustrated in the following small table, which gives the first part of the series.

Li	Be	B	C	N	O	F
7.02	9	11	12	14.03	16	19
Na	Mg	Al	Si	P	S	Cl
23.05	24.3	27	28.4	31	32.06	35.45
K						
39.11	etc., etc.					

Lithium (7.02), the element of the lowest known atomic weight excepting hydrogen, is a pronounced metal, electropositive,

and forming a strongly basic 'alkali.' Beryllium (9) is still metallic, but with boron (11) the metallic, base forming properties have vanished, and it is a weak acid former, while in fluorine (19) we have an element which is gaseous, highly negative, an acid former, and as different from lithium as could well be imagined. The next element, sodium (23.05), does not possess in a still stronger degree the properties shown by fluorine, as we might expect; on the contrary, it closely resembles lithium. A similar gradual modification again occurs as we proceed, the metallic, basic properties fading out and being gradually replaced by non-metallic, acidic properties. Silicon (28.4) is no longer a metal and chlorine (35.45) is a gas, chemically and physically much resembling fluorine. Beginning with the next element, the alkali metal potassium (39.11), a similar series of gradual transitions is gone through, followed by a sudden interruption and reversion, and this is several times repeated through the whole list, with certain modifications which it is not essential to our purpose to consider. Each set of elements beginning with a metal and ending with a non-metallic acid former is called a *period*. Those elements which fall into the same vertical column constitute a *group* or *natural family* and have a marked resemblance, lithium being followed by sodium, potassium, rubidium and cesium, the *alkali metals*, and fluorine by chlorine, bromine and iodine, the *halogens*, all of which give rise to strong acids.

This system, while presenting some difficulties, just as nearly every system of natural phenomena does, bears abundant evidence of being based on some natural cause, of the nature of which we know as yet absolutely nothing. Quite a number of blanks or 'missing links' occur, but it is generally expected that elements will ultimately be discovered which will fit into these places; an expectation which has in several cases

been realized in the most striking manner. The properties of helium and argon and their atomic weights, as at present roughly determined, do not hold out any promise that these elements will fit into any of the vacancies; on the contrary, it seems quite certain that they will not.

The abrupt jump from the halogen at the end of each period to the alkali metal beginning the next, in contrast with the gradual change elsewhere observed, is one of the most remarkable facts in chemistry. Given the existence of a periodicity of properties, we should rather expect the periods to be connected by a series of elements showing gradations in a reverse order, or at least by transitional elements of intermediate properties. We should expect to find a continuous curve with maxima and minima rather than a series of disconnected lines. While the law which makes the properties of elements a function of their atomic weights is wholly unknown we cannot assert that this must be so, and it is rather our reliance on the principle of continuity which leads us to feel that it should be so. We may assume that the connecting links actually exist though as yet undiscovered. It is on such an hypothesis that the most plausible attempts to classify the new elements have been made.

Rayleigh and Ramsay, at the close of their memorable paper on argon, read before the Royal Society in January, pointed out a possible way of harmonizing their discovery with the Periodic Law. They called attention to the variation of valency in the latter half of the second period :

Element:	Silicon.	Phosphorus.	Sulphur.	Chlorine.
Valency:	4	3 - 5	2 - 6	1 - 7
Atomic wt.	28.4	31	32.06	35.45

The next known element is potassium, beginning the third period with an atomic weight 39.11. Between this and chlorine, however, we may imagine another element,

which would form a continuation of the second period and which, following out the above order, would have an atomic weight between 35.45 and 39.11 and a valency of 0 or 8. A valency of 0 would imply absence of combining power, in other words, great inertness and molecules consisting of single atoms, both of which characterize argon. As pointed out above, the atomic weight of argon may prove to be less than the upper limit of 39.11.

Lecoq de Boisbaudran and Julius Thomsen have advanced hypotheses which consist essentially in the assumption of an eighth group of elements, intermediate between and transitional from the halogens to the alkali metals. Thomsen's table is here given, the hypothetical transitional elements being printed in heavy type. It is otherwise simply an abbreviated form of Lothar Meyer's table of the Periodic System. The dashes represent some of the missing elements above referred to, and the dots places of elements omitted for the sake of clearness.

I. Hydrogen				1	—	—	—	4
II. Lithium-fluorine	7	9	11	12	14	16	19	20
III. Sodium-chlorine	23	24	27	28	31	32	35.5	36
IV. Potassium-bromine	39	40				79	80	84
V. Rubidium-iodine	85	87				125	127	132
VI. Cæsium —	133	137				—	—	212
VII. ————	—	—				—	—	292

The atomic weights 4 and 36 would correspond to the chief ingredients of what we now call helium and argon. It must be borne in mind that the figures in the last column may be altered several units without affecting the theory.

It has been shown, however, as above stated, that helium and perhaps argon are more or less contaminated with other new elements. Until the atomic weights of these contaminating substances have been determined, it would be useless to assign them places in Thomsen's system. There are several possibilities. They may be other members of the last column.

Instead of only one transitional element between each period there may be several, and we would have, instead of only one, two or even three new columns on the right of the table. There remain several places open between hydrogen and lithium, and we cannot at present deny the possibility of unknown elements even preceding hydrogen. Although this element heads the list, there is no evidence of a natural reason for its occupying this unique position. On the hypothesis of a common origin of the elements from one primitive substance, the 'protyle' of Crookes, the existence of such substances is by no means improbable. The most exact atomic weight determinations indicate that the true unit of the whole system, the greatest common divisor of all atomic weights, if it exists at all, must be a comparatively small fraction of the atomic weight of hydrogen, a mass which could give rise to several elements still lower in the scale. The discovery of such elements would be scarcely more surprising than that of helium, and that they have not been thus far detected, even by the spectroscope, is no more remarkable than that this instrument overlooked argon.

While Thomsen's view cannot at present be regarded as more than a suggestion, it is certainly the one which best accords with our present knowledge. The Periodic System, imperfect as it still is, bears unquestionable evidence of some fundamental natural law, but it is at present as great a mystery as the natural system of plants and animals before the days of the evolution theory. The problem which the chemist faces to-day has much resemblance to that which confronted the biologist in those times. There appears to be no reason for expecting the recent discoveries to be in any way revolutionary, but they will doubtless contribute to the solution of the great problem of the chemist, not only by the enlarged conceptions which they involve, but

also by stimulating the search for new elements and the efforts to ascertain the true relation of those already known. In this sense the present year may well mark the beginning of a new era in chemical discovery.

H. N. STOKES.

WASHINGTON, October, 1895.

ECONOMICS OF ENGINEERING PUBLIC WORKS.

It has become almost proverbial that the inhabitants of new countries are in many respects lavish and extravagant. Our Puritan forefathers were undoubtedly the most rigorous and economical people that ever faced privation and hardship, yet it can hardly be gainsaid that their descendants have lost that characteristic of frugality to such an extent as to make the American people distinguished for extravagance and prodigality; notably so in this nineteenth century. As a people we have not spent our wealth on the fine arts, but on silks and velvets for clothing, on diamonds and jewelry for adornment, on luxuries in food and drink, and in similar indulgences of a low order, and we are now beginning to feel the evil results of this course of action.

This lavish expenditure of money has been made possible by the great accumulation of wealth resulting from the natural resources of the land, the wealth of the soil, of the forests, of the mines, and from the labor and frugality of the pioneers. We, of this generation, not only have felt no need to practice the economies familiar to other countries, but we have been impelled by the consciousness of our national and personal possessions to make use of them in what has often been vain and extravagant display.

Then again, this general success in the battle of life has made individuals self-reliant, or rather has prevented that feeling of the need of coöperation which only lately has shown signs of existence. There

was a time when men rose unaided to the top round of financial success, made their own fortunes, and spent them as their tastes dictated; individuals hired individuals, and laborers worked for this man or for that, as fancy or personal preference led them; but not now. By means of coöperation and combination with others, man is enabled to have advantages which, as an individual, he cannot secure; for we have begun to act on the principle that, while one man's opinions may be ignored, there is power in the expressed wish of numbers. Trusts and brotherhoods are alike in trying to secure some advantage for their individual members to the exclusion of the rest of the world. Man has reached a point where he sees that to benefit himself he must be willing to help a few others as well. One step has been taken away from individualism, but only one, and that a short one. Let us look at some instances of corporations and associations seeking their own advantage at the expense of the public good. This is sometimes done wilfully, in the face of public needs and desires, and sometimes through blindness and ignorance.

There are in the United States thousands of miles of railroad which have been uselessly built. The money for their construction has been practically taken out of the store of the world's wealth and literally buried in the ground. They have been built either by shortsightedness or by knavishness on the part of a few, and can only be maintained by a higher rate on all railroad business, and a correspondingly increased tax on all who use the railroads. No one would hesitate to say that were the New York Central Railroad, for example, to have all the freight business between New York and Buffalo, instead of having to divide with its competing roads, the rate per ton on freight would be greatly lowered and yet a working profit be maintained. Aside, then, from the local business, which

could generally be more economically managed by feeders than by trunk lines, competing lines enforce higher rates for the service rendered. Had a proper regard for public economy been maintained the West Shore Railroad, for instance, would never have been built.

Now look at the management of our municipal affairs. Water pipes under the care of one commission are laid in one trench, gas pipes under another management in a second trench, and so with the sewers and the steam pipes, and the conduits for wires and for other purposes. Each company is responsible for its own ditch and its contents, but the cost of the trench is, in each case, added to the cost of the service rendered, and the community has to pay for the many managements and their lack of coöperative understanding. It is not an unknown thing after a town is well paved to have the pavement ruined by the subsequent laying of water and sewer pipes, with the additional expense of repaving the street over the trench. Were all pipes put together in a suitable and accessible conduit, paid for by the managements of the different pipe lines, and were the conduits built before any of the trenches are dug, a certain net gain to the community would ensue. Conduits could, in most cases, be built for less than the total expense of the trenches, and could be constructed in the streets of our large cities, thus avoiding the dead loss incurred whenever the streets are torn up for repairs.

Another instance is found in our colleges and universities, where useless duplication, arising from petty jealousy and departmental rivalry, results in direct loss to the institution. One professor delivers a lecture on iron ore, as part of the course in geology, and another, lecturing on the strength of materials, goes over the same ground. One department buys a machine to test the strength of boiler plates; another

invests in one to test bridge rivets, and another in one to test building stone; while a single machine would serve all three departments were there some authoritative head to make proper arrangements.

Our elective machinery is run in the same spendthrift way. City and National elections come at different times, and the cost to the country is doubled in consequence. In November a Presidential election is held, and the following Spring the same big engine—inspectors, clerks, halls, etc.—must be put in motion, and run a whole day for the purpose of electing a school trustee or a road commissioner. With our taxes it is the same story. In February the assessors make out lists, perform all the necessary work and the State tax is collected at great expense; in June the same outlay, both of time and money, is again necessary to collect the city tax; while, were both done at the same time, nearly half the labor and expense could be saved.

Instances could be cited almost indefinitely to show that we continually spend a great deal of money to no purpose, money which does not add to the store of the world's wealth, money which, so far as any lasting good or any visible result is concerned, is absolutely thrown away. We have grown up with it, and it seems natural and necessary to us. Our vision is limited, and provided the thing to be done is done, we do not concern ourselves as to whether, or not, it is accomplished in the most economical and altruistical manner possible. New ways are being forced on us, as they have been on older countries, and as a nation we are bound to consider the questions of the hour in a broader and more communistic fashion than any individual, who weighs only the chances of his personal advantage, would do. It does not follow, that we, as a people, are not capable of improvement because there are instances

where, as a people, we have allowed ourselves to be imposed upon. The history of no other nation is so full of examples of genius in adapting the means at hand to secure required ends. Bogie trucks, pin-connected trusses, timber trestles and bridges were all called into existence by the necessities of work, and by the American genius in employing the material at hand. The modern steel construction in city buildings comes under the same head. A study of the patent office records proves that we are extravagant, not because we are incapable of developing methods, but because it has not been necessary for us to be otherwise. This seems to point to the fact that we have become accustomed to care only for ourselves and our private interests and are neglecting public economies.

There are, however, growing evidences of progress in this direction. The Interstate Commerce Law is designed to restrict railroad charges between non-competing points to what shall be reasonable rates for the service rendered. Railroad corporations can no longer obtain franchises to construct lines parallel to existing lines, unless it is clearly shown that the traffic is too heavy for one road. Four States of the Union now refuse to give the right of eminent domain to railroads, as has been done in times past. Even to obtain a franchise for an electric street line it must be shown that there is a public demand for its construction. Within the past three months the Supreme Court of New York has confirmed a decision of the State Railway Commission to the effect that no electric road may be constructed parallel to a railway, unless it is proved that public necessity and convenience require it. The Courts held that exorbitant rates on the steam railroad were to be avoided by application to the Railway Commission, and redress had through them. The public has an inherent right, however, to the best service for the least money, and

if trolley lines can give better service at lower rates than the steam roads, public economy demands their construction and use.

Deep water canals, which are awakening so much interest at present, afford another example. Heavy and bulky freight of certain kinds can indisputably be carried more economically by canal than by rail, and yet the railroads keep up a bitter competition for that class of matter, and have even been known to carry freight at less than cost in order to force out of competition the canals running along their line of way. It would be far better were the work of the railroads restricted to the transportations of perishable matter and other things whose rapid delivery is important, and all else entrusted to the canals, whose operating expenses, even with the interest on the original outlay, are generally enough smaller to make a considerable difference in the cost of transportation. The possibility of carrying freight from New York to Chicago means the possibility of carrying it from Europe to Chicago, and means also saving to the community of the cost of reloading in New York. A deep water canal from Chicago to New Orleans would mean a cheap water connection between the North and the South, and again to the Nation the amount saved on freight.

In New York a great step has been recently taken in the acquisition by the State of a quantity of land. This act of remarkable foresight is a wise provision for future citizens. New Jersey has shown equal wisdom in reserving her mountainous and water-bearing country as a gathering ground, that all her cities may have a pure and unlimited water supply.

Boston, moved, to be sure, by her own immediate needs, is about to offer to thirty or forty cities in that vicinity the opportunity to share in a large enterprise, by which each may secure good water at reduced

rates. Some years ago, Boston, in the same manner offered to the cities along the Charles and Mystic rivers a plan for the disposal of their sewage, as, by thus joining forces, the cost to each would be greatly lowered. Many examples of the recent tendency towards municipal economy might be enumerated; among others the modern sentiment on the value of street railroad franchises; the feeling that gas and water should be furnished to citizens at moderate rates; for no private company has the right to demand more than a reasonable profit; also that it is the duty of the city authorities to exercise their right of jurisdiction in these matters. There are, too, signs of growing enlightenment in the direction of caring for waste. People are beginning to realize the dead loss incurred by mixing different kinds of garbage, some of which have a value. There are now many manufactories that use as raw material what, in time past, was regarded as waste product. We might go on to speak of the folly of individuals making dirt which the municipality must clean up; to the use of water meters, to prevent waste even where there is plenty of water; all these things go to show inclination towards more careful consideration of municipal economy.

Apply this tendency to the question of water supply, and make the maintenance of its purity a question of public economy. Water is not only a prime requisite of food, but it also acts as chief among our scavenging agents. In our water works it does double duty; it brings water for cooking, drinking and cleaning into our houses, and after being made foul and unhealthy it carries away with it most of the waste of our vital processes. The large streams of a country act in the same way as the water in the pipes of a house. They bring into a city supplies for its daily life, and they carry away the waste. Since, except for the city at the river's source, the stream

cannot serve both purposes, it must be decided for each stream which service it shall perform. This question should be settled by some authority, learned not only in the quality of the stream, and its inherent fitness for being used for either purpose, but learned also in the economic phase of the question. Would the community as a whole be better served by having, for example, the Passaic river kept, by the exercise of some authority, pure and wholesome for domestic purposes, or by allowing it to be made an open sewer, a proper place for the discharge of all manufacturing waste. Shall the stream in question remain throughout its length as pure as at its source, or shall it be avowedly given up to pollution, is a question to be settled, not by asking if any one city along its banks desires to use the water of the stream for drinking purposes, but by a determination of the needs of the community. Contamination, or that which renders a stream unfit for further domestic use, is caused by the introduction of manufacturing wastes and of human refuse, and in order to keep a stream pure these two sources of contamination must be avoided, either by keeping all such matter out of the stream entirely, or by requiring some process of purification which shall render them non-injurious. It seems almost inevitable that these waste products will sooner or later find their way into the stream. It has been proved that intermittent filtration, well and carefully managed, will restore polluted water to a pure condition, and the practicability of its use for large cities is now being tested in several places in this country. The economical question to be answered with reference to any stream whose water is to be used at any point for drinking purposes, is: should the polluted water be *made pure* in such quantities as are needed for a specific use, or should the stream be *kept pure* by prohibiting its pollution at any point; that is by re-

guring the purification of waste before it enters the stream. The general trend of modern legislation is towards the latter course, no doubt due largely to the influence of the increasing number of State Boards of Health; but why not make it a question of municipal economy?

If Newark, for example, wants her water supply from the Passaic river, whose waters are polluted, does it not seem absurd, speaking broadly, that she should be required to purify her supply of twenty million gallons a day when the pollution comes, perhaps, from one mill discharging only one million gallons? If one woolen mill on a stream causes pollution that obliges a dozen cities further down the stream to construct filtration works, provided they are to drink the water with any degree of safety, would it not be more economical to oblige the one mill to purify its comparatively small amount of waste before it is allowed to enter the stream, instead of permitting the pollution of the whole river? *Vice versa*, streams already devoted to the service of mills and manufacturies may better serve the general economy by continuing in that service; and the one or two cities can build filtration plants at less cost than that of purifying the wastes of all the manufactories. Only a careful study of the condition of the communities along the banks can ascertain in which way the gain to the whole people is found, in which way public economy is best maintained.

HENRY N. OGDEN.

CORNELL UNIVERSITY.

MARINE LABORATORY OF THE UNITED
STATES FISH COMMISSION AT WOOD'S
HOLE STATION, SUMMER
SEASON OF 1895.*

THE present 'Laboratory of Scientific Research' was constructed after Professor

*This has been an especially active season at the Government and Marine Biological Laboratories at Wood's Hole. At our request Professor Peck, who

Baird's designs in the year 1884, as part of the large building which serves the department of fish culture. This is, therefore, the eleventh season during which scientific research has been prosecuted under these conditions both by government patronage and by individual responsibility, and it is instructive to look back over these years and see how many well-known workers have been accommodated here, and of how much service these advantages have been to the learned institutions which they represent, such as Yale, Princeton, Harvard, Johns Hopkins, Columbia, and the University of Pennsylvania, besides a large number of smaller colleges both East and West.

There have been present at the Laboratory this summer thirty workers, representing twenty important educational institutions of this country, and one German university; four of these institutions are various high schools of the city of Chicago. These thirty have been engaged upon such a wide range of problems that only the more notable can be mentioned.

One piece of research, by Prof. H. V. Wilson, upon the sponges from the Gulf of California and the Galapagos Islands, collected by the U. S. steamer *Albatross*, under the direction of Professor Alexander Agassiz, has drawn our attention to the value of that side of biological work. Embryology naturally fills a large place here and two phases of it have been followed. The first, by Prof. W. Patten, deals with abnormal development in *Limulus embryos*. A certain small proportion of the eggs pass through the normal formation of the perfect embryo, only to then reverse the process and fade back to the original simple egg condition; or a double embryo may be formed, or a triple embryo in regular sequence, or one side of the embryo

has been in charge of the research work at the Government station this summer, sends to SCIENCE this informal report.

may disappear. It is expected that the singular behavior of these eggs will throw some light upon the physiology of growth in the embryos. It has been the good fortune also of another of our number, Dr. Lewis Murbach, to have obtained the eggs of the beautiful medusa *Gonionemus*, which this season has been unusually abundant in the 'eel pond.' An account of the occurrence of the adult in this locality is being prepared, while material for a very complete study of the development has also been secured. This piece of investigation is well under way and has contributed much of interest to all who have followed its progress. Interesting stages in the larval development of *Perophora* have been observed by Mr. George Lefevre, as the free swimming tadpole larva settles down to the fixed state, with loss of tail and sense organs.

Much cytological study has been directed upon the ganglion cells of the central nervous system. The center of this line of research was at the room of Dr. Ira Van Gieson, who, with his assistant, Mr. I. Strauss, made many careful preparations of the ganglia of the invertebrates, Mollusca, Tunicata, Annelida, for comparative study; while some of the clearest results were obtained from the large motor cells from the brain of the Torpedo. Neurological work in other directions has attracted several investigators, and one might mention in this connection the very successful application of the methylene blue method by Mr. J. E. Peabody to the study of the distribution of the nerve termini in the sense ampullæ of the dogfish and Torpedo. The work—originally suggested and directed by Professor H. Ayres—is tending toward important results as to the sensory or glandular nature of these characteristic structures. Altogether, including several students working under the direction of the investigators before mentioned, there have been seven of our number engaged in special study of nerves by means

of Nissl's method, the Golgi, Weigert and methylene blue methods.

Another line of research, by Dr. T. H. Montgomery, Jr., was concerned with the histology of the Nemertine worms, and has added many interesting features to the anatomy, histology and embryology of that group, especial attention having been paid this season to the development of the proboscis.

It is very encouraging to note how much of the work heretofore enumerated is definitely upon its way to publication by the authors. Some of it is already promised to leading journals; some of it will be incorporated in theses to be offered for the degree of Doctor of Philosophy at our universities, and all of it will, I believe, find its way into important and useful channels. One piece of research, by the present writer, was advanced directly under the auspices of the U. S. Fish Commission. This relates to the food of fish fry, especially of the earliest stages after the embryo becomes capable of free-swimming existence and able to take food; the nature of the food of fry of from a quarter to half an inch in length of several families is demonstrated, while the results will be published, together with previous studies upon planktonic material and the food of certain adult fishes, for the Fish Commission.

Much might be said about the students who have come to this station for their first seaside studies, who ask common questions about common things, or common questions about rare things, or sometimes rare questions about common things. Their work never grows old, is never finished, and seems more important each year than it did the year before. Inasmuch as no regular instruction is provided at the laboratory, much depends upon the careful outlines of work to be furnished students who come here alone by those who have them in charge. Great help can be given to students by fur-

nishing in advance definite ideas of what forms to select for work, how to proceed, and what to read, and, if possible, by putting the student into communication with some one who is willing to give an occasional word of advice. This help may be well given in advance at the universities and colleges from which students come, as is proved by our experience this season; much time thereby is saved for them and their work is more consistent and fruitful.

Another advantage of the presence of students who are doing work of a more general character is the custom of regular towing, and of constantly bringing into the Laboratory fresh supplies of living material of many kinds. The tow net is also drawn each day by Collector Vinal N. Edwards, of this station, and this, together with the large and beautiful aquaria in the exhibition room of the Laboratory, keeps all the men engaged in special research in association with general phenomena of the most attractive kinds.

It is very interesting also to see how much material for future work is each year taken from this Laboratory. Every research worker carefully collects all that he can to furnish his basis of study during the winter to come; every teacher secures also a collection of forms for class demonstration in the coming academic year, while some come here entirely for such general collecting. In this way biological work in all of the twenty universities, colleges and secondary schools represented here this season will derive many advantages from this station. In this connection we feel that too much cannot be said of our appreciation of the excellent collecting facilities offered here by the equipment of boats and other apparatus, nor of our grateful recognition of the invariable courtesy and coöperation of the U. S. Fish Commission authorities immediately in charge of this station.

Some of the most pleasant occasions of the summer were the informal gatherings held each Monday evening, at one of the large rooms of the 'Residence,' at which some of the older members of the Laboratory described the results of their various lines of investigation. Seven different themes of original research were thus presented, while the interest was much increased by the very general discussions and questions which followed each talk.

Altogether, this has been a very successful season at the Laboratory; there has been an earnest tone of work that has made itself felt throughout. We also owe very much to the advantages coming from our proximity to the Marine Biological Laboratory, and consider that much of our success is due to being so near to the active work of that institution.

We learn just at the closing of the season of the death of the Commissioner of Fish and Fisheries, Marshall MacDonald. Our grief is very deep at this sad news, for he was to all of us who have been associated with him a personal friend whom we loved, even as we respected his most liberal mind. His generous appreciation of all purely scientific work was a direct fulfilment of the original design of Professor Baird. Commissioner MacDonald's kindness, sympathy and personal interest in the young men working at this Laboratory will ever remain as most cherished memories by those who thus knew him.

J. I. PECK.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

At the Ipswich meeting of the British Association, the Geographical Section was distinguished by the exceptionally small number of papers offered for reading, and several of those which were presented were read, contrary to the usual practice, in the absence of their authors. These facts must not be taken as implying any loss of interest

in geography on the part of the British public, but they are probably to be looked upon as an indirect result of the Geographical Congress held in London in the beginning of August which, with its surfeit of of papers and discussions by the leading geographers of the world, was naturally enough felt by many geographers as sufficient for the year.

Section E met on four days, and on the average five papers were read each day, many of them being illustrated by the lantern. The proceedings were opened by an address in which Mr. H. J. Mackinder, reader in geography at the University of Oxford, as president of the Section, brought the intellectual value of geography in education into prominence. The address commenced with a comprehensive summary of the growth of modern geographical ideas from the Middle Ages down to the time when the labors of Ritter and Peschel made geography a modern science, and prepared the way for the university recognition of the subject which is now practically universal in Germany, though unknown in Britain. The geographical argument he sketched as forming a book of three chapters—geomorphology, geophysiology (comprising oceanography and climatology) and biogeography, with a supplement to the whole in the form of the history of geography.

The address embodied the practical suggestion that a centralized school of geography, guided by geographical and educational experts, should be established in London, under the immediate inspiration of the Royal Geographical Society. The concluding words express in a sentence the truth which volumes of argument seem powerless to impress upon university authorities:

"The geographical is a distinct standpoint from which to view, to analyze and to group the facts of existence, and as such entitled to rank with the theological or philosophical, the linguistic, the mathemat-

ical, the physical and the historical standpoints."

The General Committee of the Association very appropriately appointed a committee with Mr. Mackinder as chairman and Mr. Herbertson, lecturer on geography at Owens College, Manchester, as secretary, to investigate and report upon geographical teaching in the United Kingdom.

Excellent papers on exploration were read by Mr. G. F. Scott Elliott on a journey to Ruwenzori, by Captain Hinde on the Congo State, by Mr. Myers on Caria in Asia Minor, by Mr. Borchgrevink on the Antarctic regions, and for Mr. Bent on southern Arabia; but the facts treated of had already been made public.

New results in travel were communicated by Mr. H. S. Cowper, who had made an interesting journey through Tarhuna and Gharian, in Tripoli, in bringing home photographs of many important sites previously little known, and by the Rev. W. Weston on the Japanese Alps, with an account of the curious rites practiced by the Japanese pilgrims on their visits to the mountain shrines.

Lengthened experience of a little-known land enabled Mr. John Dodd to give a paper of very high geographical value on Formosa, an island which he probably knows better than any other European, on account of his long residence there and his trading journeys among the aborigines of the interior. Dr. A. Markoff gave an account, from Russian official sources, of the conditions of the Asiatic dominions of that empire, and the probable effects of the completion of the trans-Siberian railway now in course of construction.

Mr. Montefiore, secretary of the Jackson-Harmsworth Arctic expedition, reported the return of the yacht 'Windward' from Franz-Josef Land, where she had wintered after landing Mr. Jackson and his party. Mr. Jackson started for his journey toward

the pole in March, returning twice to his base for supplies to equip the advanced station, where he will spend the coming winter; but the 'Windward' only broke out of the ice on September 7th, and her crew suffered badly from scurvy.

Major Leonard Darwin read a report on the Sixth International Congress and sketched the work done at that gathering.

In some respects the most valuable papers submitted were those dealing from the geographical standpoint with various special sciences. Astronomical geography was represented by Mr. W. B. Blaikie's remarkably ingenious Cosmosphere, a union of the terrestrial and celestial globes on which all problems in practical geography could not only be worked out, but demonstrated directly to the eye.

Oceanography had as its exponent the first British authority, and probably the first authority in the world, on the whole subject, Dr. John Murray, who discoursed on the general circulation of the oceans. Mr. H. N. Dickson demonstrated, by a series of exceptionally fine lantern slides, the results of his recent discussion of observations made on the conditions of the North Atlantic, bringing out the close relation between the axis of relatively high water temperature in the ocean and the position of the North Atlantic anti-cyclone, by which the climate of Europe is largely conditioned.

In climatology M. Ravenstein presented the report of a Committee of the Section on the investigation of the climate of tropical Africa by means of instruments supplied by the Association and employed by government officials, missionaries and traders in various parts of the continent. Biological geography was well represented by Mr. A. Trevor-Battye, who, in the course of a paper on the 'Struggle for Existence under Arctic Conditions,' insisted on the probability of the theory of instinctive return to an ancestral home being the compelling power in

the northern migration of birds for the breeding season.

And in history Mr. Myers succeeded in making clear the geographical conceptions of Herodotus by reconstructing, from the writings of the 'Father of History,' maps such as might have been used in the first discussion of these views.

HUGH ROBERT MILL,
Recorder of Section E.

LONDON.

SCIENTIFIC NOTES AND NEWS.

THE SMITHSONIAN EXHIBIT AT ATLANTA.

THE Government building at the Cotton States Exposition contains collections of great interest exhibited by the Smithsonian Institution and the National Museum. According to the pamphlet published to accompany the exhibit an attempt has been made:

1. To give as good an idea as possible of the character of the treasures which are preserved in the Museum, by presenting an epitome of its contents, with contributions from every department.
2. To illustrate the methods by which science controls, classifies and studies great accumulations of material objects, and uses these as a means for the discovery of truth.
3. To exhibit the manner in which collections are arranged, labeled and displayed in a great museum.
4. To afford as much instruction and pleasure as possible to those who may visit the Atlanta Exposition, to impress them with the value of museums as agencies for public enlightenment, and thus to encourage the formation of public museums in the cities of the South.

These objects seem to be admirably accomplished by the collections which are exhibited under the following departments: *Mammals*, including, in addition to 43 specimens illustrating range and classification, 12 of the most characteristic types of the human species. *Birds*, represented in their natural surroundings. *Reptiles*, showing the poisonous snakes of the United States. *Fishes*, including 73 of the most characteristic species. *Comparative Anatomy*, arranged by Mr. F. A. Lucas, is intended to illustrate

the structure of a considerable number of the most interesting types of the animal kingdom. *Marine Invertebrates*, in part, a continuation of the Department of Comparative Anatomy. *Mollusks*, arranged by Mr. C. T. Simpson. *Insects*, selected from the rich entomological collections of the Museum by the late Prof. C. V. Riley. *Paleontology*, including 116 species of North American fossils. *Geology*, exhibiting the occurrence of gold and silver in nature. *Minerals*, representing chemical and physical relations. *Botany* and *Materia Medica*. *Prehistoric Anthropology* and an alcove exhibiting the origin and significance of games. *Arts and Industries* and *Technology*, with special reference to industrial development. Ethnology offers exhibits of special interest, in part from the Bureau of American *Ethnology* prepared under the direction of Dr. W. J. McGee, and in part from the Department of Ethnology selected by Prof. O. T. Mason.

AN account of the Smithsonian Institution, its origin, history, objects and achievements, has been prepared by Dr. G. Brown Goode, intended to accompany the collective exhibit of the Smithsonian Institution and its dependencies at Atlanta. This should be read not only by visitors to the Exposition, but also by all who are interested in the Smithsonian Institution and the advancement of science in America. Dr. Goode concludes the article with the following paragraphs:

At the time of the Smithson bequest the endowment of research had scarcely been attempted in America. There were schools and colleges in which science was taught, and certain of the teachers employed in these institutions were engaged in original investigation. There were a few young and struggling scientific societies, very limited in extent and influence, but at that time the chief outcome of American scientific work. Science in America was an in-

fant in swaddling clothes. Fifty years have passed and American science now stands by the side of the science of Great Britain, of Germany, of France, a fellow worker, competing on an equal footing in nearly every field of research.

The Smithsonian Institution did what was, at the time of its organization, absolutely indispensable to the rapid and symmetrical development of American scientific institutions, and but for it science in America would no doubt have advanced with much less rapidity. It is also certain that the progress of American science has had an immense influence upon the welfare of America in every department of intellectual and industrial activity and a reflex action upon the scientific and industrial progress of the entire world.

In 1896 the Smithsonian Institution will celebrate the end of its first half century. A special volume will be published to commemorate the event, and two memorial tablets will be erected in honor of the founder in the city of Genoa, where he died, June 26, 1829; one in the English church, and one upon his tomb in the beautiful little English cemetery on the heights of San Benigno.

It is interesting to remember that in September, 1896, will occur not only the semi-centenary anniversary of the birth of the Institution founded in the City of Washington by Smithson, but also the centenary of the delivery of that immortal address in which Washington so forcibly recommended to his countrymen to promote as an object of the highest importance institutions for the increase and diffusion of knowledge.

GENERAL.

READERS OF SCIENCE will remember criticisms made in the journal (June 21, 1895, p. 682) regarding the illustrations in *The Standard Natural History*. The full bench of the Supreme Court of the State of Massa-

chusetts made a decision on October 19, which concerns the matter, and is of much scientific importance. Action was brought by Herman Julius Meyer, of Leipsic, publisher of Brehm's *Thierleben* against Estes & Lauriat, and S. E. Cassino & Co., for the breach of a contract made by them with the plaintiff in 1883, for the sale of plates to publish a natural history. By the terms of the contract the defendants were not to sell or dispose of the plates. It was for a breach of this provision that this suit was brought. The plaintiff claimed to be entitled to recover a \$30,000 penalty, as provided in the agreement, for a breach of the contract, as well as damages for the breach. The Judge at the trial in the Superior Court held that he was not entitled to recover. The decision now given holds that the plaintiff cannot recover the amount of the penalty, but is entitled to compensation for the breach of the agreement in disposing of the plates.

PROF. G. MACLOSKIE, of Princeton, has published in the October number of the *Bulletin of the Torrey Botanical Club* an article on 'Antidromy in Plants,' previously read before the Botanical Section of the American Association. The author reports the discovery that all species of Phænogams appear to have two castes of individual plants, born of the same mother-plant, and differing by being slightly curved in opposite directions. Phyllotaxy is only one of the manifestations of this: and all plants seem to have heterodromous phyllotaxy between the different individuals of a species, and homodromous phyllotaxy within an individual and with all the quasi-individuals produced from it by cuttings or bulbs. Thus half the members of a species are 'antidromous' with the other half, the difference apparently arising from their being derived from seeds borne on opposite margins of a carpellary phyllome. In some cases plants derived from the same root-stock, as Iris,

Colla-lily and Rush, are relatively antidromous. Antidromy is a primitive character, affecting mother-seed, embryo, stem, leaves and inflorescence. It is frequently disguised and concealed by secondary changes, as twining of stems and contortions of flowers, spreading out and opposition of leaves. It affords a ready solution of puzzling problems, and is useful in suggesting new problems and new lines of discovery.

THE Huxley Memorial Committee is expected to take prompt action in the matter of organizing an American Committee. The latest reports from Professor Howe indicate that substantially all the American scientific men who have been thought of as possibly willing to serve have, so far as approached, signified their willingness to do what they can in the matter. The biologists are likely to be well represented, particularly, and the leaders in scientific work in every field will do their full share. It is hoped and anticipated that the contributions from the United States will rival those of Great Britain and exceed those of any other nation.

At a meeting of the Graduate Students' Association of the Johns Hopkins University, on October 11th, brief addresses were announced by Professor Brooks, on 'Huxley;' by Professor Rowland, on 'Helmholz;' by Professor Welch, on 'Pasteur,' and by President Gilman, on 'Dana.'

Nature states that a commission has been appointed charged with undertaking a systematic geological survey of Cape Colony. The commission intends to prepare at once a bibliography of all previous publications relating to the geology of the Colony.

THE late Professor Babington, of Cambridge, bequeathed to the University his entire collection of plants. His botanical library was presented to the University in 1888.

PROFESSOR E. E. BARNARD, of the Lick Observatory, has removed to Chicago, although the Yerkes Observatory will not be ready for use during the coming year.

PROFESSOR RAOULT, of Grenoble, has been awarded, for his chemical researches, the biennial prize (20,000 fr.) of the French Institute.

A FORMULA occurring in the account of Dr. Artemus Martin's paper read before the American Mathematical Society appears in SCIENCE, No. 39, Sept. 27, 1895, p. 395, as

$$z=(p^2+q^2)(r^2+s^2), \pm 2rs(p^2-q^2),$$

instead of

$$z=(p^2+q^2)(r^2+s^2) \pm 2rs(p^2-q^2)$$

DR. ROBERT BELL, assistant director of the Dominion Geological Survey, states that he has discovered a river larger than any other stream in the province of Quebec, together with a great area of timber land and a country suitable for agricultural purposes. This new river, for which the Indians have no name, is larger than the Ottawa, and Dr. Bell affirms it to be the sixth of the great rivers of the world. Its average width is considerably over a mile, and it has expansions many miles in width. It flows through a level country and is very deep. The river is five hundred miles in length, and would be navigable for steamers until toward James Bay, where there are great rapids.

DR. EDWARD W. BEMIS, lately professor in the University of Chicago, has become associate editor of the *Bibliotheca Sacra*, giving especial attention to applied ethics, economics and civics.

ACCORDING to the New York *Evening Post*, Prince Henry, of Orleans, in a letter to the Société de Géographie, gives an account of his journey from Mong-tse to Ta-li-fu. In this hitherto unexplored country, 750 miles in length, he has taken 500 photographs and collected 300 zoölogical specimens. He will return to France next January.

THE Roxburghe Press, London, is about to issue the *Nursing World and Hospital Record*, a journal for trained nurses, who, it is calculated, number nearly 30,000 in Great Britain alone.

BANGS & Co., New York, announce the sale of the library of the late William Berrian, including many scientific works.

SPON & CHAMBERLAIN announce 'Polyphase and Electric Currents and Alternate Current Motors,' by Professor Silvanus P. Thompson. The subject is dealt with under the following diversions: Generators for Polyphase Currents; the Properties of the Rotatory Magnetic Field, with some account of its historical development; the Theory, Construction and Performance of Polyphase Motors; the Theory and Construction of Motors operated by ordinary single-phase Alternate Currents; together with some account of Polyphase Transformers, and of the measurements of power in polyphase systems. The same publishers announce an elementary text-book on 'Steam Engines and Boilers,' by Prof. J. H. Kinealy, of Washington University.

At the International Congress of Otology held recently in Florence many papers were presented, but they nearly all belonged to clinical medicine. The Sixth Congress will be held in London in 1899.

It is reported that petroleum wells in Java are very productive and are becoming important commercially.

THE English Consul in St. Paul de Loanda reports that the Trans-African Railway is now open for a distance of 300 km. and will be continued to Ambaca.

MR. FRANKLIN L. POPE, known for his contributions to electrical science, was killed on October 13th (aet 66), from electrical shock while examining the connections in his own house. In 1870 Mr. Pope invented with Mr. Edison the one-wire printing telegraph, and in 1872 he invented the rail

circuit for automatically controlling block signals, a patent largely in use on the principal American railroads. He was also the author of the 'Electric Telegraph' and 'Life and Work of Joseph Henry,' and was for several years editor of the *Electrical Engineer*. In 1885 he was elected president of the American Institute of Electrical Engineers.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Stanford estate has just won its second victory in the suit of the Government to recover \$15,000,000 from its funds. A demurrer by the attorneys for the estate, alleging want of equity was sustained by United States Circuit Judge Ross, and this decision was sustained by the United States Circuit Court of Appeals, Judges Gilbert, Hawley and Morrow. The case goes to the Supreme Court for final decision, but it is felt that this decision must be in favor of the estate. The interest in the matter arises from the fact that this money was intended by Senator Stanford as the ultimate endowment of Leland Stanford, Jr., University, and the establishment of the Government's claim would seriously cripple the future of the University.

THE British Treasury has decided that the annual grant of which King's College, London, was deprived under the late Government may be restored to the College next year without any stipulation as regards tests.

ABERDARE-HALL, Cardiff, founded in 1885 in connection with the South Wales University at Cardiff, for the training of women students, has now been formally dedicated.

THE registration in the freshman class of the University of Minnesota at the present time has reached a total of 628. This number is distributed as follows: College of Science, Literature and the Arts, Classical 43, Scientific 126, Literary 114, Teachers' 25—308 in all; College of Engineering, Met-

allurgy and the Mechanic Arts, all courses 64; College of Agriculture, 4; College of Law, 107; Colleges of Medicine, Medicine and Surgery 71, Homeopathic Medicine and Surgery 8, Dentistry 48, Pharmacy 18.

The Faculty of the College of Engineering, Metallurgy and the Mechanic Arts, University of Minnesota has recently been strengthened by the addition of two men; Frank H. Constant, assistant professor of structural engineering, comes from the Osborn Company, Civil Engineers, Cleveland, where he held the position of assistant engineer and obtained a wide experience in designing and constructing bridges, roofs, elevated railroad tracks and other structures. Between graduation and joining Frank C. Osborn in the above named company he was in the employ of the King Bridge Company. Mr. Constant graduated with distinction at the University of Cincinnati in 1891, after taking his mathematical and professional training under Henry T. Eddy and Ward Baldwin. H. Wade Hibbard, assistant professor of machine design, is a graduate of Brown University and Sibley College, Cornell University, where he won high distinction. After graduating from the last named institution he entered the employ of the Pennsylvania Railroad Company and remained with the chief mechanical engineer of that system for three years, directing construction and repair in the Juniata shops, going to England and the Continent to investigate railway practice and performing other responsible duties. At the end of that time Mr. Hibbard was secured by the Lehigh Valley Railroad as chief draughtsman, which responsible position he held until his call to Minnesota.

It is stated that Birmingham is spending £50,000 on a central technical institution; Manchester, £130,000; Salford, £55,000; West Ham, in the East of London,

£40,000; Wigan, St. Helen's and Derby, £20,000 each; whilst Liverpool is having plans prepared which contemplated an outlay of £80,000.

DR. F. DIMMER, of Vienna, has been appointed to the chair of ophthalmology at Innsbruck in succession to Dr. Czermak.

THE University of Texas has opened its twelfth annual session with about 225 students.

THE report of a committee consisting of Lord Playfair, Lord Welby and Sir M. W. Ridley, M.P., appointed to consider the desirability of a fixed age for the compulsory retirement of professors under the crown has been published as a Parliamentary paper. The principal conclusions arrived at by the committee are that there should be fixed rules as to superannuation of presidents and professors, and that they should be made by college statutes and not by an Order in Council. When a professor reaches 65 years of age the president of the college should be bound to report to the government the condition and efficiency of the teaching. If these are and continue to be satisfactory, the professor need not be superannuated till 70, but at this age his retirement should be absolute. In regard to presidents, the committee is of the opinion that the age of 70 should be the period of retirement, but, should the visitors of the college formally report that the college would suffer by the loss of the experience which the president has acquired, the Treasury, and not the Irish office, should have power to continue him as president for a certain number of years not exceeding five, so that at the age of 75 the retirement of a president should be absolute.

CORRESPONDENCE.

A FEW MORE WORDS IN REGARD TO THE NEW BIBLIOGRAPHICAL BUREAU.

IN SCIENCE for August 23d I took the liberty of explaining, in a brief way, some of the

principal features of the new Bibliographical Bureau for Zoölogy. I was not, however, able to compare the system adopted with the numerous suggestions which had been made in this journal by correspondents interested in this important question. I shall now attempt to do so as briefly as possible.

In the first place, let me state that the work will agree closely with the propositions formulated by the Harvard Faculty. In elaborating this plan, I have been obliged to travel to almost every country of Europe, and to consult several hundred zoölogists and bibliographers from all parts of the world. It seems, therefore, a very significant fact that these two independent plans should show such striking similarity. This circumstance seems to show most conclusively that there is a real want felt for just such an organization of the service.

The features in which we differ from the plan of Professor Bowditch (not counting those where we simply go farther) are the two following: (1) The greater centralization of the work. We did not want to depend upon the coöperation of the authors. Our arrangement does not exclude the other. If the authors can be induced to aid us it would be a great saving, but we must be able to get along without their direct aid. (2) The notes appended to the titles by the Bureau are not intended to be *résumés*, but are to be concise statements of the *topics treated*. To make a *résumé* requires too special knowledge on the part of the bibliographer for it to seem practicable. This is the province of the Zoölogical Record and of the 'Jahresbericht,' and it is best not to duplicate their work.

In Professor Hale's letter I was much interested in his idea of a 'Bureau of Scientific Correspondence.' This is almost exactly what we shall offer. I differ from your correspondent merely in the minor point of not fancying a restriction in the matter of language to English and French.

The bibliographical part of Professor Todd's scheme corresponds too obviously with our own to need special comment. The same is true in regard to Dr. McGee. I should, however, like to call attention to his remarks on non-commercial

publishers. It is the basis of the coöperation that we ask.

Dr. Goode's letter reads almost like an introduction to our prospectus. I shall take up his numbered paragraphs successively and note the differences, where there are any. (1) The catalogue to be international, bearing the imprint of no society or organization; the same language to be used in the notes added as in the original, no restriction to English and French; Slavonic, Scandinavian and Oriental titles to be translated into French, German or English. The only way in which this would differ from our decision relates to the Scandinavian languages, these being kept in the original just as Italian or Spanish. (2) I fear that Dr. Goode would set a higher standard of comprehensiveness than we have done. (3) Dr. Goode chooses in favor of an annual form of publication, while our Bulletin will be fortnightly. The morphological titles will, however, be reprinted in the 'Jahresbericht,' so that this requirement can in part be met. It is possible that provision may ultimately be made for similarly bringing together the systematic part. (4) The annual lists would be indexed alphabetically under authors' names, as suggested; and, for cross reference, the year, the author's name and the running number will be used. A 'pasting' edition is also called for in the adopted regulations. In regard to the suggestion that the Mährenthaler typesetter be used for this work, it may be of interest to note that this has proved impossible; the company does not recommend its machine for broken work in which several faces of type are necessary. The remaining sections of the letter relate principally to the comprehensive scheme of a complete catalogue of science. They can, in my opinion, best be attained by the creation of federated bureaus for the branches. In this way it is possible to adapt the system to the special needs of each science, and yet to have the entire field adequately covered, as desired by the Royal Society. The criticism which Dr. Goode makes of the card system seems to be fully justified. It is a bulky contrivance, and, while it is doubtless indispensable to the worker and to libraries, yet it cannot wholly supplant other forms of publication. The New Bureau will combine both

methods, using the same type to print the several editions.

Mr. Weeks has also very fairly indicated the limitations of the card catalogue, and makes many of the same suggestions as Dr. Goode. I fancy that our Bureau would meet the needs set forth by Mr. Ramsay, each person being able to arrange his cards as he might see fit.

Finally, I find the methods of the Bureau in substantial agreement with the methods of Dr. Josephson, except that his 'Bureau for Natural and Physical Science' seems too little specialized.

In conclusion, let me refer to certain modifications of the system, which have been proposed in articles in other periodicals, or in personal letters to me or to one of the National Committees. In an interesting Russian note advocating the new Bureau, Prof. Mitrophanov suggests that a larger part of the work be left to National Bureaus. This step has not seemed wise for the reason that the work could not be uniformly done unless centralized.

Prof. Nachtrieb, who has been kind enough to abandon a similar enterprise in order not to conflict with our own, urges the adoption of descriptive words in place of the symbols which it is proposed to use; and a similar suggestion is made in an Italian article which I have received from Prof. Camerano. I think that these critics do not realize the fact that these symbols will often be very numerous, and that they are to be used in classifying the card when received rather than in consulting the catalogue. It is undoubtedly easier to run through a package of cards in search of the number 7 than to read each word in search of a long polysyllable; but when the cards are once classed, there is no need of even doing this; the guide cards would then be used. It must be remembered that it is not necessary to use these symbols save when they are needed, *i. e.*, in having the cards put in place by a person unfamiliar with the science. In fact this has been a feature which has been especially recommended by a number of persons. Mr. Dewey and Mr. Peckman Mann have gone still further in this direction and have urged the adoption of the 'Dewey System.' It remains to be seen whether this system would not become too complicated when applied to the

several cross classifications which we shall have to employ. It will also be necessary to see whether these symbols cannot be placed in a less conspicuous place on the cards. This is not so easy as would at first appear, for it must be remembered that the same type must be used for the pamphlet edition.

I have now passed the more important notes in review, hoping that this may facilitate future correspondence. Permit me to state, in closing, that I should be delighted to receive further suggestions in this regard. I must beg, however, some indulgence if I should find myself unable to reply promptly to all friends of the undertaking; the correspondence has already assumed such proportions that it is almost impossible to attend to it single-handed.

HERBERT HAVILAND FIELD.

THE DOGMATISM OF SCIENCE.

TO THE EDITOR OF SCIENCE—*Sir*: "The hardest of intellectual virtues is philosophic doubt," it has been said, and viewing the statements and the facts, one is inclined sometimes to assent to it in a literal way, *i. e.*, as an unintentional statement of the hardness, density or impenetrability of much that passes under the name of philosophic doubt. By the words, however, it is supposably meant that this 'philosophic doubt' is a virtue above all others, and that it is only the extremely virtuous who may ever reach this lofty pinnacle of greatness. To this I demur. As Heine said: We are natural protestants, and certainly the spirit that denies, *der Geist der stets verneint*, is as a matter of fact the easiest and the most common of 'virtues,' though Goethe and humanity have agreed in personalizing it as distinctly Mephistophelean, rather than angelic, or even manly. I should add that "the mental vice to which we are most prone is our tendency to assume that" our *Verneinung* in the name of science of all the religious and poetical truths that have been gained by humanity has anything virtuous or logical or scientific about it.

As to what is virtue, intellectual or moral, and as to what may be logical, there will never be an end of discussion, but as to what is scientific there should nowadays be convictions so indubitable that discussion should end. Even

the typical scientific dogmatist must admit that science properly considered is the unprejudiced, colorless observation of facts and the inductions from these facts *only so far as the facts will carry*. But the fundamental thesis of a certain class of scientists is that biologic facts are all explainable by the forces of 'mechanical energy and physical matter.' To ordinary—what I should call normal or healthy—minds, this is as perfect an example of deduction, theory or dogmatism as could be stated. So long as the old materialistic bauble of spontaneous generation remains the the veriest will-o-the-wisp, the most undemonstrated and undemonstrable absurdity, so long have these 'scientists' not a shred or shadow of evidence that their dogma has any genuine scientific basis. For every biologic fact there must be posited the unexplained, and so far in-explainable fact of life itself, of sentience, or 'sensitive' or 'irritable' protoplasm, as the very beginning of the fact. To say in advance that this life, sensitiveness, irritability, etc., is explainable upon the principles or forces of physics is in most absolute contradiction of the scientific spirit, and one who dogmatically asserts it has yet to learn the a b c of scientific method. The scientist who thus commits scientific suicide may charitably be excused on the ground that he is a victim of the subtle laws of psychologic heredity, that he is an 18th century atheist masquerading as scientist, one with a dissident dogma unwarrantably compelling science to a service from which she must instinctively rebel.

In a recent letter to SCIENCE Professor Brooks pathetically pleads for a united front of all scientists against the 'Vitalists,' and that the 'dogmatism of biologists' must be attacked at both ends of the line. This rallying cry for unanimity of utterance rather than for adherence to personal conviction is sadly suggestive. It would seem that a more 'virtuous' ideal would be that of following truth rather than partisanship. 'Failure to agree' is stigmatized, but it might be politic to first ask who are the disagreeers. The answer to that question might result in the finding that Professor Brooks and his party are the disagreeers or sectarians, because if my observation is correct the scorned vitalists, as Professor Gage avers, constitute the

immense majority of scientific workers, and the few materialists who presume to speak in the name of their scientific brethren have no brief so to represent them. The cool assumption that biologic science is coterminous with physics is difficult to correctly characterize—politely. The refutation of that dogma has been made a hundred times and no adequate answer to these refutations has ever been made. Take one of these refutations, Beale's *Protoplasm*; no dispassionate and logical mind, knowing aught of the history of science or the laws of logic, can deny that the arguments and facts there set forth leave the dogmas of scientific materialism smashed to utter and everlasting smithereens.

An amusing corollary of the scientific dogmatists is that "consciousness and volition cannot cause structure or anything else," and that function is always the result of structure. This is, of course, necessary to the materialistic dogma, but "it can be stated without fear of refutation" that no one, not even Professor Brooks, ever observed a single fact of physiology, plant or animal, in which function did not precede structure, and surely before he could write his denial his 'consciousness and volition' set to work the machinery that moved his pen. Are the pseudopods of the *amœba* 'structures?' Did not the function of *amœboid* locomotion precede the locomotion of truly structural organs, such as feet and fins? Did not the desire for movement precede *amœboid* movement? Did not the desire create the structureless pseudopods? If function is always the result of structure, what then created the structures, *e. g.*, the million structures of the unborn fetus? The logic of the situation is that as 'consciousness and volition' have no organs, so far as any scientist knows, of which they are the outcome, it follows that consciousness and volition are only 'the empty shadow of changes that go on in the physical basis'—*i. e.*, they do not exist. If the facts do not tally with our theory so much the worse for the facts—let's flatly deny them existence. Of 'beliefs held because they cannot be disproved,' the most perfect of illustrators are surely those children in science who dogmatically wage Quixotic warfare against dogmatism.

Of the many charming self-contradictions of

Professor Brooks' delightful letter that I should like to mention, none is more suggestive than his 'demand' that we accept as our sole scientific creed the desire to find out "whether life is or is not different from matter," and "whether thought is or is not an agent," and yet the beginning, middle and end of his entire letter is, one might say, soaked in the dogma, determined in advance, that there is no 'whether' at all, and that it 'is flatly contradicted by most investigators.' His contempt for those who still entertain the 'whether' is,—to put it most courteously—the limit of childish *naïveté*.

GEORGE M. GOULD.

PHILADELPHIA, October 15, 1895.

THE INVERTED IMAGE ON THE RETINA AGAIN.

PROFESSOR BROOKS' statement concerning the inverted image on the retina, in a late number of *SCIENCE*, has called to my mind an experiment in optics which I stumbled upon as a boy one Sunday night in church when the sermon had extended beyond my powers of listening. As I have not seen an account of the experiment in the usual statements regarding the demonstration of the inverted image on the retina, I venture to give the matter for whatever it may be worth.

My attention having been attracted by the 'beams' of light which seemed to shoot off towards the ceiling and toward the floor from one of the gas jets of a chandelier, I aimlessly pushed against the *under* eyelid with my finger, and was surprised to see one of the beams of light, the *upper* one, shorten and lengthen, according to whether I opened or shut the lower lid. On repeating the experiment with the *upper* lid, I obtained the same results on the beam which appeared to pass *downward* from the gas jet. By closing one eye and carefully squinting with the other at the distant gas jet and working my eyelids in the manner above described, it was at once evident that the outer termini of these beams were cut squarely off, and that the end farthest from the gas light was in some way by refraction hinged to the edge of my eyelid. In short, as these red 'rays' formed part of the opposite sides of a cone, with the gas light at their apex, and the base at the contact of the edge of my eyelids

upon the cornea, it was evident that the whole phenomenon, gas light included, was in my eye so far as sight was concerned. In short, since, when a movement of the lower lid lengthens or shortens the 'rays' which appear to shoot upward toward the ceiling, and a movement of the upper lid *vice versa*, one can see that the image in his eye is inverted, because the sides of this cone and the background of the room are reversed.

If one will work this experiment to the point of perceiving that the picture of the outside world is entirely in his eye, he may come, as I did, to the fearful demonstration that even in 'full light' outside of his eye all is in a certain sense total darkness. It is a dreadful momentary concept, more dejecting than the fear which attends the coming on of blindness from destroyed vision. J. B. WOODWORTH.

CAMBRIDGE, MASS., October 12, 1895.

It follows from Mr. Woodworth's observation that the image on the retina is inverted. The 'rays of light' are not, of course, objective, but are due to imperfect accommodation. The light from a gas jet passing through the lower half of the pupil is in part refracted downward, affects the lower half of the retina, and is projected as rays extending upward. The same inference can be drawn from an examination of *Purkinje's figures* (the blood vessels of the retina), subjectively and objectively; or, indeed, by pushing the eyeball upward, in which case objects seem to move downward.

It is commonly believed that the external world sends up through the nerves little images of itself which are examined by the mind. This seems to the present writer a 'dejecting concept.' *Per contra*, the fact that the world in which we live is a mental construction assigns to mind its due place in the universe.

J. McK. C.

'CRYING WITH TWO EARS.'

IN SCIENCE for October 11th (page 487), Professor J. McK. C. corrects an inaccuracy in Professor Brooks' statement concerning the inverted image. He closes his criticism with the paragraph: "A similar paradox is the fact that with two images on the retinas we see things singly. This may also be treated without undue

seriousness by the question: 'If we hear a baby crying with two ears, why do we not think it is twins?'" What terrible sort of baby is it that cries with two ears? I protest against such a little monster. Is it not sufficient that a baby cry with one throat, and that we hear it with two ears? And are there not times when we think it is triplets? W. H. FISHBURN.

SECOND PRESBYTERIAN CHURCH,
COLUMBUS, O., October 12th, 1895.

INACCURATE ZOÖLOGY.

THE EDITOR OF SCIENCE—*Sir*: It appears to me that zoölogists should endeavor, whether for their own good or that of the science they cultivate, to see that popular zoölogical works are prepared by zoölogists, instead of being compiled by persons comparatively ignorant of the subject. Perhaps the most effectual means to this end consists in pointing out the inaccuracies of works which have not been written with sufficient knowledge, so that the public may be more careful about what it accepts. No one appreciates more than the present writer the great difficulty of ensuring perfect accuracy, and it is not suggested that those who might be criticised have not done the best in their power; the point is, rather, that the services of specialists should in every case have been secured.

Even so, curious errors will sometimes appear; perhaps usually due to the writer trying to cover too much ground. Thus in the *Standard Natural History* there is a figure of a *Pulvinaria*, called '*Coccus adonidum*;' this latter name belonging really neither to a *Coccus* (as now understood) nor a *Pulvinaria*, but a *Dactylopius*!

A few days ago the new *Standard Dictionary of the English Language* (Funk & Wagnalls Co., 1895) was received, and on looking over it I at once stumbled on the following curious items:

- (1.) The cotton scale-insect is 'a bark-louse (*Pulvinaria innumerabilis*). There is no recognized cotton scale-insect in this country, though there are scale-insects which affect cotton. *Pulvinaria innumerabilis* is not a cotton species, but affects maples in the North. *Cottony* scale is doubtless what was intended.

- (2.) Coccidæ have scale-like *larvæ* and live in plants.
- (3.) A picture of a snail shows a sinistral shell, so also does the figure of *Limnæa stagnalis*. The snail is labelled *Helix pomatia*, but the figure appears to represent *Helix aspersa*.

And so on in other cases, although the bulk of the zoölogical information seems correct.

This morning was brought to me a little book which the New Mexico Territorial Board of Education have under their consideration for adoption in the High Schools. It is called *Zoology for High Schools and Academies*. (American Book Company, 1895, pp. 216.) The authoress is Margaretta Burnet. I could not very well recommend its use, after reading in it such things as the following:

- (1.) p. 90. Scale insects belong to Aphididæ.
- (2.) p. 132. Daddy longlegs is an example of the Scorpions.
- (3.) p. 59. Figures of three 'Fresh water snail-shells.' The middle figure is a *Succinea*. On p. 56 a *Succinea* is correctly figured as a land snail.

Yours truly,

THEO. D. A. COCKERELL.

MESSILLA PARK, NEW MEXICO.

SCIENTIFIC LITERATURE.

Allgemeine Physiologie. Ein Grundriss der Lehre vom Leben. Von MAX VERWORN. Mit 270 Abbildungen. Jena, Gustav Fischer. 8vo. Pp. xi., 584.

This work is a very acceptable addition to the series of biological text-books issued by Fischer of Jena, and takes its place worthily. In size and general appearance it conforms to the model adopted by the same publisher for Hertwig's Embryology, Wiedersheim's Comparative Anatomy, Ziegler's Pathology, and other familiar authoritative and important manuals.

Verworn attempts to present a summary of principles of physiology applicable to both plants and animals generally. He covers, therefore, somewhat the same ground as Claude Bernard in his classic work of 'Les Phénomènes de la

Vie communes aux Plantes et aux Animaux.' But whereas the French physiologist included much original research in his work, his German successor gives rather a collation of the results hitherto attained. It is certainly unfortunate that 'General Physiology' has been treated as a stepchild of Biology and left pretty much to shift for herself. Verworn renders, therefore, a substantial service in his book by directing attention rightly, and at the same time presenting many aspects of the subject in so comprehensive a manner as greatly to facilitate the further pursuit of this neglected branch of biological science. Such an attempt, when first made, must necessarily be partially successful at the best, because the material to be brought together is scattered in a great variety of memoirs, and occurs often as an incidental part of researches upon some problem of special physiology, vegetable or animal.

We must judge such a work by what it contains, not by what it omits. The first chapter, which occupies nearly sixty pages, seems to me inappropriate, and not to add to the scientific usefulness of the whole. It deals with 'the ways and means of physiological investigation,' according to the title chosen for it by the author. But ways and means do not signify to him practical methods, but rather a series of philosophical and metaphysical concepts, which appear to me neither very profound nor original, and which certainly lack any obvious bearing on the rest of the work. The chapter, however, includes a brief historical review of the progress of physiology. This review is well done.

The remaining chapters are properly physiological; their titles will indicate their chapters:

Chapter II. On the living substance.

Chapter III. On the elementary phenomena of life.

Chapter IV. On the general conditions of life.

Chapter V. On stimuli and their action.

Chapter VI. On the mechanism of life.

In each chapter will be found many facts collated, such as one cannot readily find elsewhere brought into mutual relations. For example, in Chapter IV. there are considered the present conditions of life in the world, the origin of life on the earth and the history of death, and in Chapter V. the general nature of stimuli, and

the effects of stimulation on the cell, including chemical, mechanical, photic, electric irritations, with discussions of chemotropic, barotropic, heliotropic, thermotropic and galvanotropic phenomena, and also sections on fatigue and exhaustion.

The author shows throughout that he has received a sound scientific training, that he has a good grasp of his subject since he handles all its themes firmly and successfully, so that his book will be found very useful to those who in their teaching wish to give due prominence to the fundamental principles of biology.

In another edition there will be many changes and additions to make, which will improve the work and render it a more adequate representative of the present status of general physiology. So long as the author deals with philosophical aspects of the subjects it must be deemed a serious omission not to include consciousness. We may note other omissions, such as the phenomena of senescence and growth as a function of age, an omission which is significant to me personally, owing to my having long been specially interested in senescence as a biological problem. Again, the difference between sex and sexuality is left unconsidered; the theory of the vital force as having a ferment-like effect, the causation and laws of variability, concerning which a good deal is known, and finally many minor points, which are known to this and that specialist, all suggest opportunities for improvement. None the less the book as a whole is to be commended, for it takes a great step towards bringing order in a field of science still chaotic, and it is to be hoped that it will become well known in American Laboratories.

CHARLES S. MINOT.

Ice Bound on Kolguev. By A. TREVOR-BATTYE. London, Constable. 1895. Pp. xxviii. and 458. Three maps and numerous illustrations.

The small Arctic island which forms the subject of this sketch is an interesting place, as it lies just within the Polar circle, to the north of Russia, between the entrance to the White Sea and the mouth of the River Petchora.

The two attempts which were made to colonize the island in the latter half of the eighteenth century resulted in failure; and at

the present time the Samoyede families who eke out a miserable existence there can hardly be called a successful venture in that line, because the conditions of life force them to a nomadic career, which puts an end to all development.

With regard to the structure of the island, the author was not able to find any trace of the rocky character which has usually been assigned to it. He describes the surface as one composed mainly of sandy hills, which are confined to the central and northern portions, while the southern districts are occupied by tundras of considerable extent. The soil of these tundras, frozen solid during a great part of the year, and only thawed out to a depth of a few feet at best during the summer, limits the amount of the food supply in the most thoroughgoing manner.

About 110 plants have been reported from the island and of these 95 were secured by the author. He also records 47 birds and 6 mammals.

The descriptions given in the book, particularly those of the birds and their habits and the portions devoted to the plants, are well done, and much interesting information has been put in a very agreeable form; here and there, however, one occasionally detects in the effusive style the zeal of the 'glorified naturalist.'

The volume is in the main well written, but some portions would be apt to cause the grammarians to shudder. As, for example, where we are told that "Powys kept our spirits up with the banjo, and we sang, skinned and ate many figs" (p. 52).

Our naturalist has done much painstaking work in spite of the comparatively hurried character of his trip. It is, however, to be regretted that the portions upon the Samoyedes and their manners and customs were not more carefully expanded. Enough is said to whet the appetite for more. On this island we find perhaps one of the few remaining opportunities for the study of a nearly pure form of bolvan worship; and if the author had not allowed his feelings of civilized disgust at some of the native performances to get the better of him, he might have worked himself more thoroughly into their good graces, and given us some insight into the rites of Nûm, the Arctic god. As it is, the subject is dismissed with a footnote and an ac-

count of the superstitious dread of the Russian sailors, which was produced by the knowledge that he had at least one of these 'rag dolls' on board of their vessel.

He cites the Eskimo as observers of this form of worship, but as far as they are concerned it is hardly possible that such is the case. They believe in spirits, but have not personified or individualized them in the shape of idols. The opportunities to investigate such characteristics are getting more and more rare each year, and it is a pity that any are missed.

The author has evidently not learned one of the essentials of a good explorer, and that is the ability to take things as they come. There is a sort of spirit of sad reluctance in the statement, "For breakfast we warmed our last night's lamp, pulled the wick out, and then ate the grease with black bread. It was not a *recherché* meal, but it was economical." There are instances all through the book of an evident feeling of dislike, or perhaps unrest, under the circumstances, which is hardly consonant with the best work. One is almost constrained to say that no one should venture into the field as a naturalist who is not willing to deny himself, in all matters of private convenience, for the sake of the object in view. Nothing is more apt to betray a man so quickly as an expression of his likes and dislikes.

It is to be regretted that their vessel, the Saxon, was allowed to run away with the dredges, alcohol and bottles for their work; since through this neglect they were deprived of the chance of bringing back a much larger amount of material.

There is much enjoyable reading to be found between the covers of this volume, more, perhaps, than is usually the case in books of travel. The formula for finding one's pathway after the fashion of the Cree Indian, upon pages 123 and 124, is not to be recommended to the average traveller who has strayed from his bearings. It is only the keen observer of little things who can 'shut his eyes,' think over the trail of some hours past, locate a given object and then proceed straight to it. Ordinary mortals had much better stick to their compasses, and not try to imitate the power of a genius, or even attempt to do what they have seen those who undoubtedly

possessed a large knowledge of the country do with comparative ease. The reviewer has often been through such experiences, and at first they seemed marvelous evidences of power, but later information dispelled much of the haze of glory which enveloped them. Still, we can all thank the writer for a good story well told.

A single word should be said upon the character of the illustrations. They are uniformly of a high character, and much taste has been shown in their selection. They are an ornament to the book as well as a help to the reader, and their execution is in almost every instance a credit to the designer. Of the maps, that of the island, and that showing the distribution of the ice fields about the island, are noteworthy. They are a valuable addition to our knowledge of this part of the globe, which now serves only to support the few families, who are in reality the Samoyede partners of the Russian traders from the district of Archangel.

The book is most cordially recommended to all lovers of books of travel.

WILLIAM LIBBEY, JR.

Major James Rennell and the Rise of Modern English Geography. By CLEMENTS R. MARKHAM, President of the Royal Geographical and of the Hakluyt Societies. New York, Macmillan. 1895. The Century Science Series. Pp. 232. \$1.25.

Rennell is pronounced, on the excellent authority of Markham, to be 'the first great English geographer.' He early gained an outdoor experience in a seven-year service as a midshipman in the navy, and then in 1764 was to his surprise appointed Surveyor General of Bengal at the youthful age of twenty-one. He returned to England in 1777 and resided there until his death in 1830. After completing his Bengal Atlas he turned from field surveying and became a deep student of geography, ancient and modern, of lands and of seas. It is noted that he was 'depressed by the aspect of public affairs and the wretched mismanagement of the American Revolutionary War.' It was in his later years, while a neighbor and associate of Sir Joseph Banks, that the element of attractive personality and invigorating companionship appears strongly in this biography

as in the lives of so many English men of science. Brought together in the world's metropolis, we read not so much of isolated reflections in the quiet study as of familiar intercourse in the brotherhood of congenial tastes. After the death of Banks, in 1820, Rennell was the acknowledged head of English geographers. Travellers and explorers came to him with their rough work, projects were submitted for his opinion, reports were sent to him from all parts of the world. The Raleigh Club was formed in 1827, 'for the attainment at a moderate expense, of an agreeable, friendly and rational society, formed by persons who had visited all parts of the world.' After Rennell's death the formation of a Geographical Society to supply his place became a necessity, and thus largely from his impulse was founded what has become the greatest force in geography to-day. Exploration rather than explanation was then naturally the direction of earth study; and it is chiefly in this division of geography that the English still follow their leader. W. M. D.

Oeuvres ophtalmologiques de Thomas Young, traduites et annotées par M. TSCHERNING, précédées du portrait de Young, de son éloge par François Arago et d'une préface par EMILE JAVAL. Publication faite aux frais de la Fondation Carlsberg. Copenhagen, Høst et Son. 1894. 80 pp. x+248.

Among the great men who have inaugurated important epochs in science there are two classes; the first, writing with a fertile imagination and extraordinary capacity for work, have developed one or more kindred ideas and have achieved results of great perfection; the second class, while endowed with imagination no less, or perhaps even more powerful, have, in the absence of persistent, concentrated effort, followed the caprices of an intellectual curiosity which led in divers directions, and the works of their genius which have been preserved are consequently less perfect both in form and substance. Their writings are often intricate and obscure; but this very complexity not infrequently invests them with a peculiar charm for the thinker.

The most distinguished of the first type of mind was Isaac Newton; the most remarkable

of the second type was Thomas Young. Newton turned all the efforts of his genius toward mathematics and physics. To facts carefully observed he applied the powerful aid of the calculus and gave one of the finest examples of the fecundity of the mathematical method. The works of Laplace, Ampère, Cauchy and, in a certain measure, those of Fresnel are the product of a similar spirit. Works of this class are usually crowned with recognition and honors during the lifetime of their authors; for sooner or later, by the force of logic, they are able to rise above the never-failing hostile coalitions of mental inertia and the vanity of mediocrity in power. The same good fortune, however, is not the part of such works as those of Thomas Young. Mathematician, physicist, naturalist, physician, philologist and engineer, he has left profound traces of his originality in each of these domains; yet in not one of them was his genius recognized by his contemporaries. Endowed with extraordinary intuitive power, he was able to assimilate with marvellous rapidity the most varied kinds of knowledge, the consequence of which marks all his writings with a conciseness of language and exposition which, for the ordinary student accustomed to long and minute reasoning, gives to them an obscurity oftentimes discouraging.

The complications of Nature are infinite, and never in her manifold manifestations does she take into account the categories among which our intelligence is forced to divide itself up both in methods and reasoning. There is not a phenomenon in the animate world which has not its characteristics at once physico-chemical and mathematical; and the stating of biological problems in the form of problems in physics accessible to mathematical calculation is always attended with great difficulty. Young treated biological problems, especially those of ophthalmology, in this spirit, which was not then, and is not now, that of the medical profession. As a natural result he was not understood by his confrères, or was understood only sufficiently to be considered their adversary; an attitude by no means calculated to enhance his scientific popularity. He had besides the honor of being able to furnish an elegant interpretation of the curious phenomenon of the coloration of soap-bub-

bles and other thin transparent substances; also he explained phenomena not previously known, such as the shadow produced on a screen by the superposition of two luminous rays proceeding from the same source and arriving at the same point by different routes of unequal length; or, again, the augmentation of light which appears periodically when the differences of the respective routes vary. He saw that these facts were admirably explained by the hypothesis of undulations in an imponderable medium which, according to the concordance or discordance of their periods, mutually added to or destroyed each other; an hypothesis, it will be seen, diametrically opposed to that advanced by Newton. Notwithstanding his endeavor to place his idea under the patronage of his illustrious predecessor, the theory of interferences was denounced as sacrilegious by powerful adversaries, who held the public conscience and who never relinquished their hostile attitude.

But Young was 'not without honor save in his own country;' the recognition denied him in England has, thanks to a happy accident, been freely accorded in France. It was at the hands of the great Arago, himself interested in optics, that he received his first encouragement, followed by academic honors. In any case, it is in the works of Fresnel, who was inspired by the same principle, that Young's achievements were for the first time crowned with approbation; and it was the experiments of Foucault on the rapidity of the propagation of light through air and through water which gave the fatal blow to the emission theory and secured for the theory of interference a final victory. For some time past the physicists have shown a certain indifference concerning the undulatory and molecular theories, doubtless because of the superficial generalization built upon these theories twenty years ago. We cannot refuse to them, however, in spite of their hypothetical character, a marvellous rôle in discovery (as, for instance, the experiments of Herz on electrical undulation) as well as a system of representation quite satisfactory to the mind which does not seek to make a universal application. However this may be, Young has other claims to the admiration of physicists, as, for instance,

the first efforts made to unite by an empirical formula the elastic forces of vapors and their temperatures.

The works of Young in ophthalmology have not attracted the attention they merit, notwithstanding the liberal recognition of their results on the part of Helmholtz and Donders. Maxwell, Helmholtz and Rood have popularized his theory of colors which consists in attributing to the retina three kinds of fibres responding respectively to the three fundamental colors: red, green and violet; and producing by their combined impression the sensation of all the other colors; in like manner the combination of these three primary colors in variable proportions is able to produce all the appearance of colors. This hypothesis admits but a single mode of transmission of the impression through the nerves to the brain. It makes the differentiation of the sensation of color consist in a functional modification of the periphery rather than in a cerebral operation. But, while it offers a plausible explanation of certain cases of color-blindness, this theory is far from having obtained general acceptance. It seems difficult to apply it to the explanation of those cases of color-blindness where but a single color is perceived and that different from the fundamental colors of Young. But it must be admitted that Young did not advance his hypothesis without reserve, and the theories which have since undertaken to supersede his are scarcely more satisfactory; they are not susceptible of any better experimental proof nor of theoretical deductions.

A distinguished ophthalmologist, M. Tscherning, has just published a French translation of Young's works on ophthalmology with liberal commentary. The subjects therein treated appear in the following order:

1. Observations on Vision. (Philos. Trans. for 1793.)

2. A memoir 'On the Mechanism of the Eye.' (Philos. Trans. for 1801.)

3. Extracts on the vision of colors taken from different essays.

4. The 38th chapter of *Lessons on Natural Philosophy*, London, 1807: *On Vision*.

'Observations on Vision' were written at the age of twenty and present many remarkable re-

flections; take, for instance, this idea (which is developed by Chevreul in his voluminous volume *On the Law of the Simultaneous Contrast of Colors*) that those colors which, when combined, approach the nearest to white, produce, when placed side by side, the most agreeable effect. This opinion regarding the complementary colors is too absolute, as has been shown by a number of recent works; but it is a first step in the science of the harmony of colors.

The lesson 'On Vision' terminating the work is a brilliant *résumé* of the knowledge of that time, together with the writer's personal ideas on the subject of ocular dioptrics, showing from the point of view of design in Nature all the advantages of the optical construction of the eye. The eye, as we know, is a sort of *camera obscura*, at the back of which is the retina. Before reaching the retina the luminous ray must pass through an *ensemble* of transparent media, which offers all the advantages of the convex lens without its inconveniences. We know, furthermore, that the luminous rays which strike the margins of the lens have their focus or point of meeting *in advance* of the focus formed by the rays which penetrate the center of the lens, to obviate which disturbing feature in photographic instruments a diaphragm is devised which cuts off the marginal rays. The iris of the eye, that membrane with its constantly contracting and expanding circular opening, placed in front of the crystalline, exercises the same function. Young shows how Nature aids still further in this direction by giving to the crystalline a gradually increased density from surface to center, thanks to which the focus of oblique rays is made almost to coincide on the entire concave surface of the retina.

The *mémoire* 'On the Mechanism of the Eye' is the most important of the work; it is remarkable for the complexity of means employed. The laws of refraction in media of uniform density had long been known; the author shows how the total index of refraction of a lens varies according to the index of refraction at the surface, when the density of the sphere or the lens varies according to the power of the distance between the surface and the center. This applies to the crystalline. He shows that the

total index of the lens is greater than the index of the center when the index, as in the case of the crystalline, is greater for the center than for the exterior. The number he got for the total index was found almost precisely correct by Mathiesen. It is in this same *mémoire* that appears for the first time a description of the *Optometer* with which Young made his principal determinations, the most complete that have ever been made of a single eye; but the instrument never came into general use and the translator was unable to find any trace of it. The principle upon which it was constructed (by Scheiner) is of a simplicity truly remarkable; a straight line down an oblong cardboard, and an ordinary visiting card perforated at one end with two pin holes, will give a fair idea of this ingenious device. By closing one eye and placing the other at the pin holes, which are held at one end of the straight line, the line in question appears no longer as a single line. To the eye looking through the pin holes two distinct lines present themselves which gradually tend one toward the other till they meet, and their point of meeting constitutes the nearest point of distinct vision. Any one may possess this simple contrivance home-made; by a system of graduation on the cardboard one may readily obtain a correct measurement of the position of the eye's focus. The experiment will show how difficult it is to fix the point where two lines cross, and the reason is that it requires considerable practice to be able to place one's eye in perfect repose, *i. e.*, to paralyze its accommodation.

Young had a large, prominent eye; which last feature he utilized with a compass to obtain an exact measurement of its length, which he found to be 23.11 mm. It was with his optometer that he discovered *astigmatism*, the unequal refracting power of the eye in different meridians; the exact degree of which he measured by the focal distance of the lens adapted to its correction. This visual defect he here speaks of for the first time, but without seeming to attach to the discovery any special importance. Young presents very complete notions on the following subjects: the field of vision; the field of perfect vision; the sensibility of the retina, less at the *fovea* than at

the periphery; on the field of regard; the fitness of the form and place of the retina for the production of a distinct image; the power of dispersion by the eye for different colors. Finally he takes up the famous problems of the mechanism which produces accommodation. To produce a distinct image of a given object on a screen the lens must be placed at a certain fixed distance from the object; how is it then that the screen known as our retina is able to receive distinct images at different distances? This problem is one not yet solved in all its complexity. The explanation offered by M. Tscherning is that the alteration required in the crystalline to form an image of objects near by is produced by the tension of the borders of the crystalline, thus increasing the convexity of the center. This is also Young's idea. Helmholtz sought to explain the alteration of the crystalline by an entirely different mechanism. Before entering upon the subject Young undertakes to eliminate the various other causes which might be invoked in elucidation of the problem. To prove that the cornea bears no part in accommodation, he neutralizes its refracting power by immersing it in water and substituting in its place a lens, and observes that there is no change in the range of his accommodation. One cannot but be struck with admiration for the patience and ingenuity which such an operation supposes. The decisive argument in favor of a change of form in the crystalline is derived by Young from a fact which Wollaston and Helmholtz sought in vain to verify, but which is verifiable on the eyes of youth, *i. e.*, the correction of the aberration during accommodation. His determination of the nature of crystalline alteration was due to another fact which has just recently been verified—that the capacity of accommodation is half as much again greater at the center of the crystalline than at its periphery; from which he concluded a flattening of the surfaces at the periphery.

It will be seen by this brief review to what an extent the ideas of Young on ophthalmology are still fresh and of absorbing interest; more than any other he has prepared the way for the final solution of these problems.

CHARLES HENRY.

PARIS.

SOCIETIES AND ACADEMIES.

THE ENTOMOLOGICAL SOCIETY OF WASHINGTON.

THE 110th regular meeting was held October 10, 1895.

Mr. Hubbard read a paper entitled 'Additional Notes upon the Insect Guests of the Florida Land Tortoise,' in which he gave his observations of the past summer, including a number of facts supplemental to his article on this subject published in *Insect Life*, Vol. VI., No. 4. The list of regular inhabitants of the burrows of the Florida land tortoise now reaches 19 species, of which 18 are insects and one is a vertebrate (*Rana aesopus*). Aside from these, 5 insects are constant visitors to the burrows. The paper was briefly discussed by Messrs. Schwarz and Gill. Mr. Schwarz referred to the possible finding of a similar insect fauna in the burrows of the European Testudos and of the two other American species of *Gopherus*. Dr. Gill showed that the European species do not make burrows, and argued that in spite of the close resemblance of American forms to the Florida species we must not necessarily assume that they are burrowers. Mr. Schwarz said that the inhabitants at Penas, a station on the Mexican National Railway, near Laredo, informed him that there is a burrowing tortoise in the great sand plains near that place. This he thinks may be *G. berlandieri*.

Mr. O. F. Cook made some general remarks under the head 'Insect Collecting in Africa,' describing some of the rarities which he had found, giving in some detail his impression of the insect fauna of Liberia, and describing his experience with driver ants. These insects, he thinks, may be responsible for the almost total absence of snakes in Liberia, since when snakes are gorged with food they are motionless and defenseless and are easy prey for these active and voracious ants. Mr. Schwarz remarked that no trace of a more or less permanent nest of *Eciton* has ever been found, and the queen is not known. These ants make temporary nests and are in the main peripatetic. The fact that we do not know the queen, however, argues that a true nest will some day be found. He called attention to the fact that the Rev. P. Jerome Schmidt has found a species of *Eciton* in North Carolina.

Mr. Ashmead read a paper entitled 'Rhopalosomidæ, a New Family of Fossorial Wasps.' Mr. Ashmead founds this new family upon *Rhopalosoma poeyi*, a Cuban species described by Cresson, specimens of which have recently turned up in different parts of the United States. Much discussion exists in the literature as to the proper systematic position of this insect, Westwood, Frederick Smith, Cresson, Haliday and Nylander having assigned it variously to the Ichneumonidæ, Braconidæ, Poneridæ, Sphegidæ and Vespidæ. Mr. Ashmead's studies led him to place the species as the type of a new family of fossorial wasps, which will form a link between the Vespidæ and Sapygidæ. Discussed by Messrs. Marlatt, Schwarz, Gill and Uhler, mainly in regard to the fact that the insect seems to lack a fossorial facies.

L. O. HOWARD,
Secretary.

NEW YORK ACADEMY OF SCIENCES.

THE Academy met on October 14 with Professor R. S. Woodward, chairman of the Section of Astronomy and Physics, in the chair. 22 persons were present. The secretary presented verbally the minutes of the preceding meeting.

There being no business, the Section of Astronomy and Physics immediately organized, and listened to the first paper of the evening by Professor Harold Jacoby, entitled 'The Reduction of Astro Photographic Plates.' This paper was read by title, and was explained as being a discussion of the best formulæ for the reduction of the photographic plates taken by the International Committee for the Photographic Mapping of the heavens. It will be published as a bulletin of the Committee at Paris. Professor Jacoby then showed some lantern views of apparatus and astrophotographic plates taken at the observatory at the Cape of Good Hope.

The second paper was read by R. S. Woodward: 'Results of Experiments on Metallic Spheres Falling in Water.' Professor Woodward, after detailing various attempts to obtain data upon the law governing the motion of spheres in a liquid, reported the results of a preliminary series of experiments, made at Co-

lumbia College last June. The experiments were performed by dropping spheres of steel, silver, aluminum and platinum in a tube of water sixteen feet long and one foot in diameter. The spheres vary in diameter from one-half inch to two inches. The interesting results of these preliminary tests are that all the spheres acquired a constant velocity inside of the first meter. Newton's law that resistance to motion is proportional to the square of the velocity seemed to be verified. The times of falling were determined with a Hipp chronoscope. More elaborate experiments with the same apparatus will be made later. This paper was discussed by Professor Jacoby and others. W. Hallock reported upon some summer work, explaining the action of the vocal cords in voice production, and described the photographs taken of the cords while in action, illustrative of their operation.

The Academy then adjourned.

WM. HALLOCK,
Secretary of Section.

NEW BOOKS.

An Introduction to General Biology. WILLIAM T. SEDGWICK and EDMUND B. WILSON. 2d Edition. New York, Henry Holt & Co. 1895. Pp. xii+231.

Darwin and After Darwin. II. Post-Darwinian Questions Heredity and Utility. GEORGE JOHN ROMANES. Chicago, Open Court Publishing Co. 1895. Pp. x+344. \$1.50.

Weather and Disease. A Curve History of their Variations in Recent Years. ALEX. B. MACDOWALL. London, The Graphotone Co. 1895. Pp. 82.

Chemical Experiments, Prepared to Accompany Remsen's 'Introduction to the Study of Chemistry.' IRA REMSEN and WYATT W. RANDALL. New York, Henry Holt & Co. 1895. Pp. x+156.

An Atlas of the Fertilization and Karyokinesis of the Ovum. EDMUND B. WILSON and EDWARD LEAMING. New York, Columbia University Press, Macmillan & Co. 1895. 4to. Pp. vi+32. \$4.00.